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Canadian Aeronautical Journal

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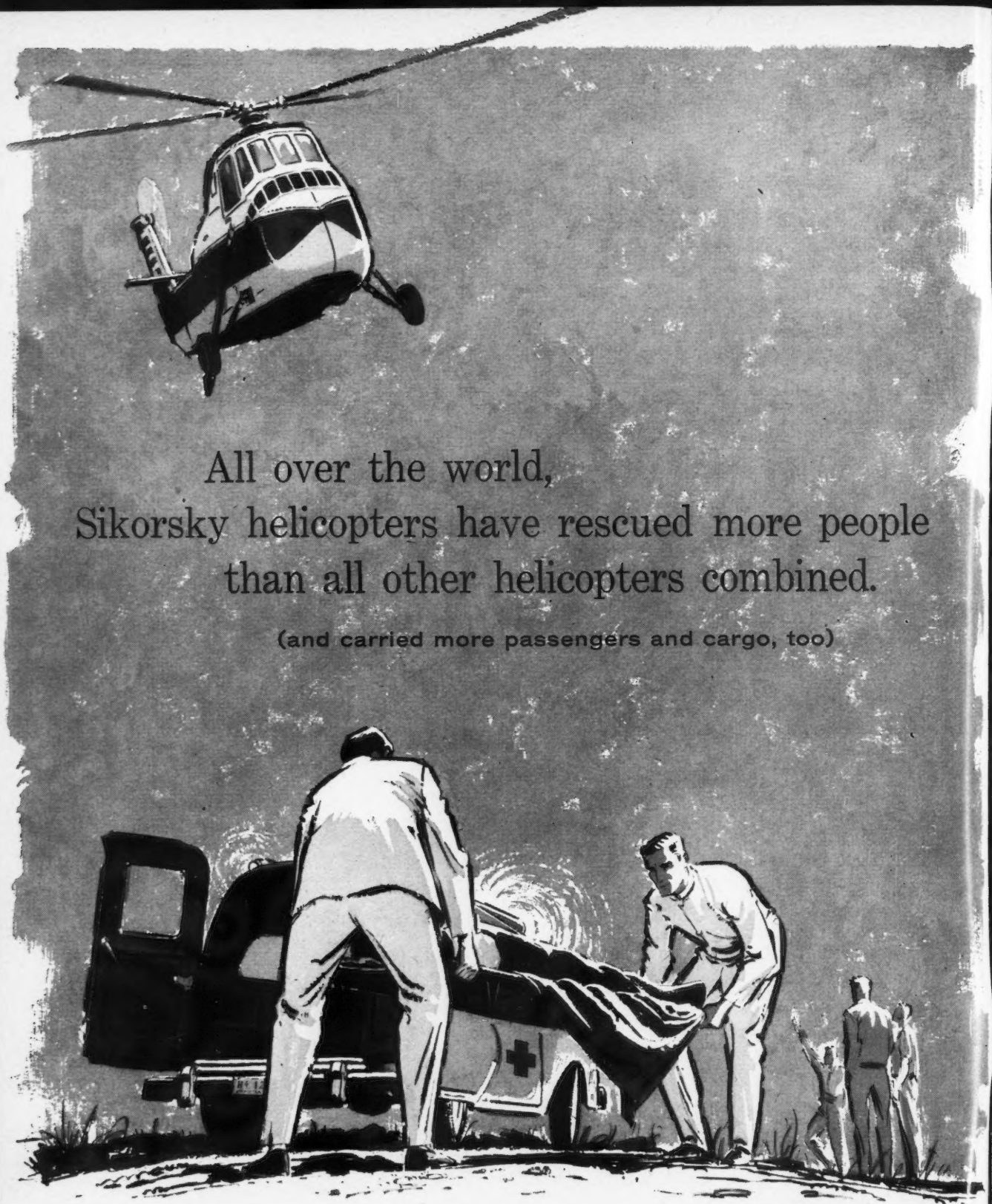

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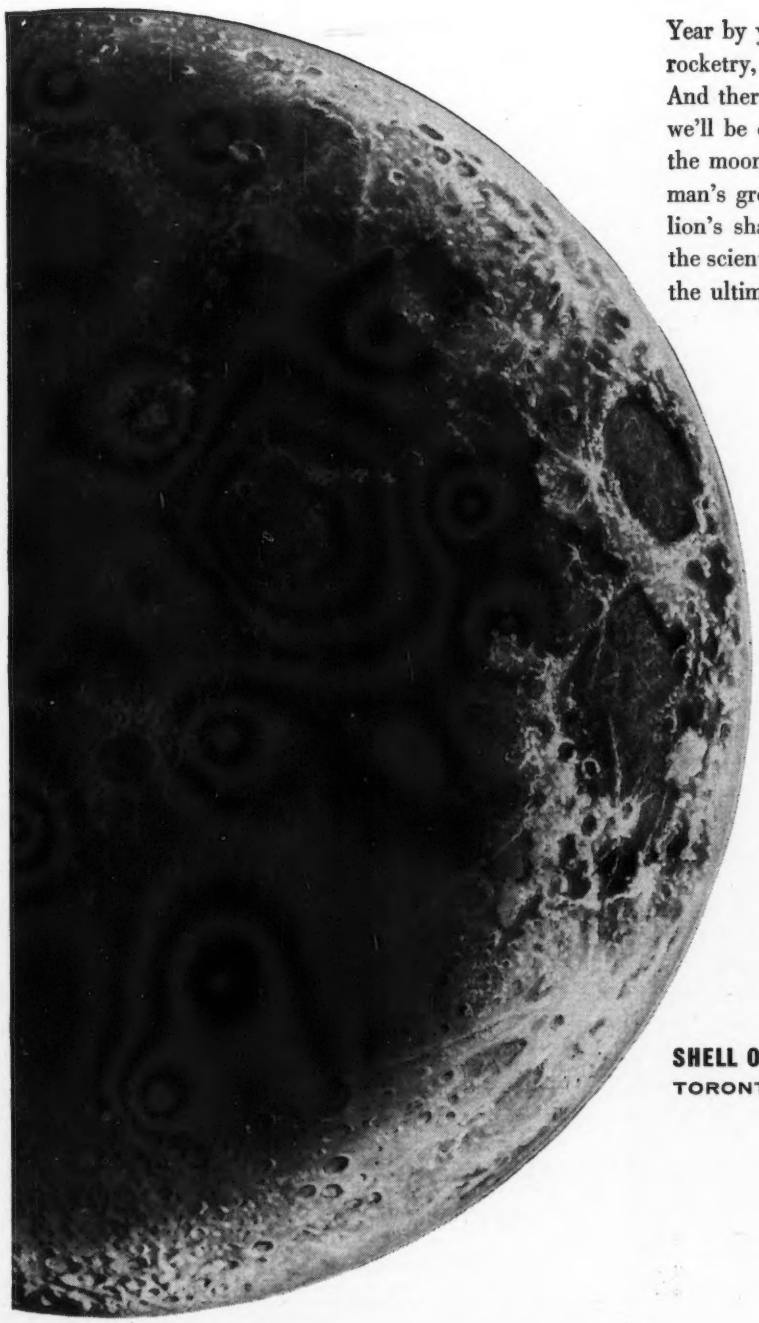

Year by year, with each new advance in rocketry, our solar system grows smaller. And there's no doubt that one day soon we'll be cheering the first man to reach the moon. His flight will rank as one of man's greatest achievements . . . but the lion's share of the credit will rest with the scientists now working to bring about the ultimate conquest of space.

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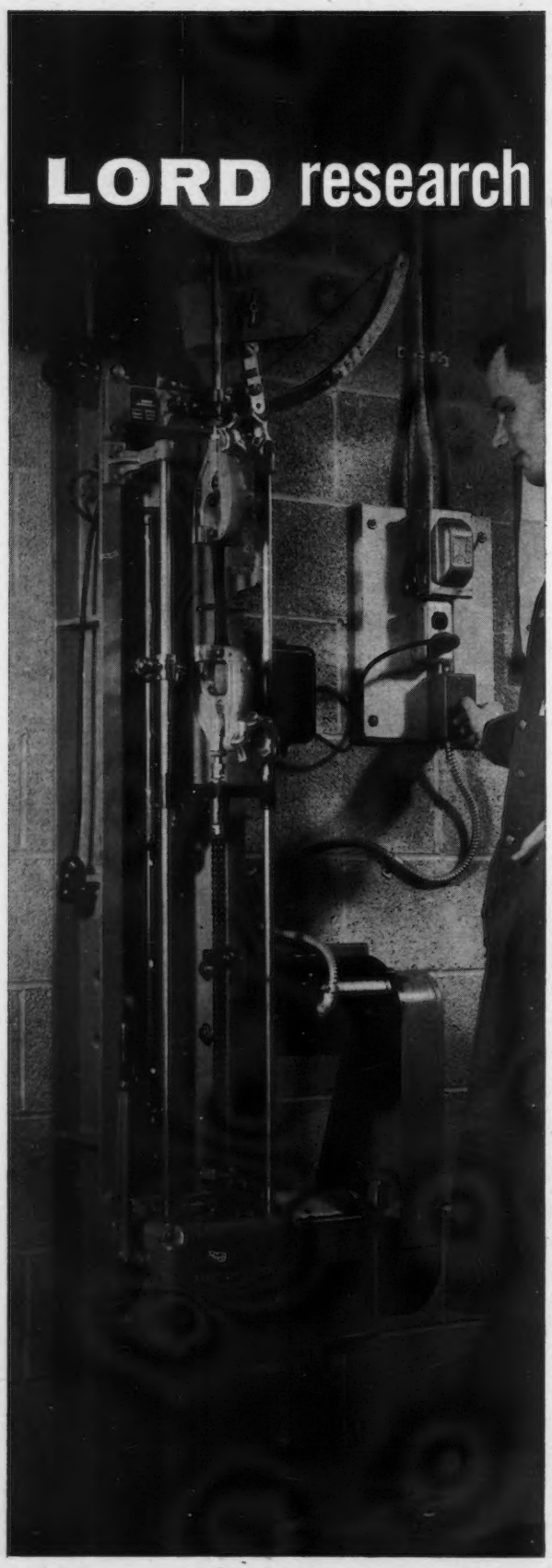

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THE PRESIDENT 1959-60

EDITORIAL

THE PRESIDENT'S MESSAGE

DURING the past year Canadian aviation has celebrated the completion of half a century of progress. Surging with pride, the Institute has risen to this great occasion with a monument at Baddeck to the pioneers.

In its turn, the Institute has been signally honoured on 29 June, 1959, by a visit and address by our patron, H.R.H. The Prince Philip.

As if to remind us that progress never comes easily or automatically, however, the year has brought a succession of difficulties, readjustments and upsets to the aeronautical industry. These troubles naturally concern the Institute. But in a remarkable way, mettle shows in the gloom as it dawns on us that aviation is already off on the next leg of the course. It is already evident that the next fifty years of progress will show present accomplishment to be the merest beginning. It is also evident that the problems will tax our wit and resource to the limit.

We of this new Council are doing our best to add a year's sound construction to the good work of our predecessors. This will require the support of all members and the advice and criticism of many.

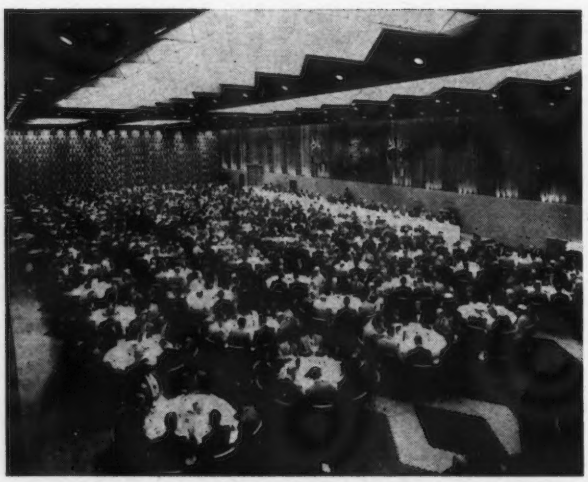
DR. D. C. MACPHAIL
President 1959-60

ENGINEERS AND SCIENTISTS LUNCHEON TO H.R.H. THE DUKE OF EDINBURGH

In Toronto, on the 29th June, a group of 1140 engineers and scientists met in the Canadian Room of the Royal York Hotel for a luncheon at which His Royal Highness the Prince Philip was the Guest of Honour. This group comprised members of the Canadian Council of Professional Engineers, the Canadian Institute of Mining & Metallurgy, the Chemical Institute of Canada, the Engineering Institute of Canada and the Canadian Aeronautical Institute. The Right Honourable C. D. Howe presided. The Head Table included the Presidents of the five organizations, a number of eminent Canadian engineers and scientists (including the Honourable J. A. D. McCurdy), the senior technical officers of the three Armed Services and representatives of the Associations and Corporation of Professional Engineers of all the Provinces.

As a member of the organizing Committee, the Secretary attended the Reception to the Head Table guests. He took the opportunity, offered by a brief conversation with the Prince, to present a C.A.I. lapel pin to him, as Patron of the Institute. His Royal Highness graciously accepted it. He began to put it on, but thought better of it, in deference to the other four organizations, and slipped it into his pocket. The Secretary also reminded him that this was the fiftieth anniversary of flight in Canada and drew his attention to the presence of Mr. McCurdy. The Prince showed great interest and went over directly to speak to him.

At the Luncheon, in introducing His Royal Highness, Mr. Howe said: "Members and Presidents of the participating societies and ladies and gentlemen. The Professional Engineers and Scientists of Canada are greatly honoured today by the presence of our guest speaker. His Royal Highness is a former President of the British Association for the Advancement of Science and the Honorary Patron of a number of associations of engineers and scientists, among them our own Canadian Aeronautical Institute. His contributions to their work and his interest in their objectives have been outstanding in the history of the science and engineering professions. Prince Philip has visited Canada on several occasions and has shown particular interest in the frontier areas of our country. There are few of us who have seen so many of our big exciting developments as has His Royal Highness.



General view of the Canadian Room of the Royal York Hotel during the Luncheon

Gentlemen, His Royal Highness, The Duke of Edinburgh has graciously consented to address you."

The Prince Philip's address is reproduced in full on the following pages.

The planning of this event had been going on for about two years. Early in 1957 the C.A.I. suggested to the Secretary of State that His Royal Highness might attend the Fiftieth Anniversary Dinner on the 23rd February or, failing that, might address the Institute, as its Patron, during the Royal Tour of Canada in this Fiftieth Anniversary year. At about the same time the E.I.C. certainly, and perhaps the other organizations, approached the Secretary of State with similar requests. In reply to these enquiries, the Secretary of State advised the various societies to get together and arrange one engineering and scientific event. Accordingly the Secretaries of the five organizations mentioned above have been working together to this end. Special credit is due to Col. T. M. Medland, Executive Director of the Association of Professional Engineers of the Province of Ontario and his staff, who carried the load of all the local arrangements.

ADDRESS BY H.R.H. THE DUKE OF EDINBURGH TO CANADIAN ENGINEERS AND SCIENTISTS

At a Luncheon held in Toronto

29th June, 1959

I WOULD like to say how much I appreciate your invitation to address you today. It would have been more appropriate, I think, if you had addressed me. Every now and then I get invitations of this sort and while I consider them a great honour I always try and get out of them in order to avoid the labour of trying to concoct something to say. The course between platitudes and controversy is a rocky one, as most people who speak in public very soon find out.

However, in this particular case things are a little bit different because I think it's about time some more was said about the very solid and spectacular developments and achievements which have taken place in Canada in recent years.

There is hardly any field of science, engineering or technology in which Canada cannot show some outstanding example. Canadian medical and nuclear scientists have done and are still doing work out of all proportion to the numbers of people involved. The aeronautical engineers have fully lived up to the early courage and ingenuity of their predecessors who designed and built, and of Mr. McCurdy who flew the Silver Dart fifty years ago. I don't suppose any country in the world has made such phenomenal progress in the development of their natural resources, or taken such trouble to try and make the new towns which will provide the work-people for these developments into satisfactory human communities.

Perhaps the most dazzling achievement of all is the cause of our present visit to Canada—the completion of the St. Lawrence Seaway for ocean going ships. There is much more to this than the very considerable engineering accomplishment. I think this project demonstrates the tenacity and strength of purpose of the Canadian character. Years of delay and frustration never discouraged and never deflected the purpose of those people who had the vision and the ambition to connect the centre of this continent to the oceans which are the commercial highways of the world.

It is this combination of technical ability with the qualities of foresight and enthusiasm which has made all these things possible. It is characteristic, therefore, that far from being content with commercial success at home, Canada also accepts her responsibilities as a member of the British Commonwealth of Nations.

In February of this year I visited an undertaking of quite exceptional interest. At a place called Warsak in the North West Frontier Province of Pakistan a party of 150 Canadians are helping their fellow members of the Commonwealth to construct a dam 235 ft high and 750 ft long—a power station to produce 240,000 kw and an irrigation system for 120,000 acres on the Kabul river. The project was initiated under the Colombo Plan and apart from the practical help in the way of technicians and experts Canada is also contributing some fifty million dollars to the project.

This is only one example in the growing pattern of inter-Commonwealth co-operation and help. It has long been recognized that the wealthy individual has a moral obligation to help those less fortunate than himself. In case this obligation should ever be forgotten most governments have established a system of taxes as a reminder.

The same obligation is now recognized to exist between nations. It is recognized that an explosive situation will inevitably develop if the gap between the 'have' nations and the 'have-not' nations grows too big. At the moment international taxation is confined to supporting international agencies. The major work of direct assistance is done by the voluntary contribution of individual governments both in cash or in kind. Cash by itself is seldom enough. Know-how, technical skill, and experienced scientists and engineers are the means by which the well-off can help the less well-off.

But one thing further is necessary if this sort of help and co-operation is to be really effective and this point is made very clearly in the Koran where it is said "Verily, God Almighty does not improve the condition of people unless they themselves strive for it". From what I saw in Pakistan they are striving for it with a whole heart.

Looked at this way, the project at Warsak is much more important than the purely civil engineering undertaking. Its real value lies in the fact that it is in essence a civil and electrical engineering university. The project is in fact providing courses of instruction for every one of the 8,000 men employed, from truck drivers to engineers, from plant managers to designers. The total value of this Canadian contribution to the improvement of conditions in Pakistan is impossible to calculate and it is certainly very much greater than the cost in pure money to Canada.

I know perfectly well that there are wonderful opportunities here, I know that there are any number of projects waiting to be tackled but it is worth remembering that the same is true of the underdeveloped countries of the world. The gap between the 'haves' and the 'have-nots' will steadily widen with catastrophic results unless the more fortunate nations singly and in co-operation make a real attempt to bring them along the path to a higher standard of living.

Many people pay lip service to the ideals of better international relations and many people seem to think that this can be achieved simply by talking. In fact more is achieved by nations working together to complete solid, practical projects for the benefit of those who most need it. Warsak is the most convincing proof of this fact and therefore it is my hope that we shall see many more Warsaks in the years ahead.

Mr. Chairman, I am most grateful for the opportunity to pay tribute to Canadian science and engineering. I wish you every success in your future undertakings.

R.Ae.S. — C.A.I. — I.A.S.

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5th, 6th and 7th October, 1959

On each day	Morning – 9.30 a.m.	Two Technical Sessions
	Noon	Luncheon
	Afternoon – 2.00 p.m.	Two Technical Sessions
On the 7th October	Evening – 8.00 p.m.	Conference Dinner

(*Canadian papers will be presented in the afternoon and morning of the 5th and 7th respectively*)

PARK PLAZA, TORONTO
15th and 16th October, 1959

15th October	Morning – Visit to De Havilland Aircraft of Canada Ltd.
	Afternoon – Visit to Defence Research Medical Laboratories
	Evening – Dinner
16th October	Noon – Luncheon at University of Toronto, Institute of Aerophysics
	Afternoon – Opening new Institute of Aerophysics Laboratories

THE DEVELOPMENT OF CANADIAN AERONAUTICAL ENGINEERING†

by Professor T. R. Loudon*

The De Havilland Aircraft of Canada Limited

Professor T. R. Loudon

IN presenting the following, I have tried to give a reasoned chronological account of the development of aeronautical engineering in Canada, at the same time interjecting some descriptions of events with which it has been my good fortune to be associated. I make no apology for some of the discontinuity in the narrative. Almost everytime during the past few months when I made up my mind about what to say, especially about this celebration, some other person published the same idea in much better form than I could have done; until finally in despair I thought I would appear here and present you with a list of excellently written articles and explain that there was nothing more to say! But Dr. Patterson and Charles Luttman would not hear of this so it seemed to me that a description of the events leading up to and the actual establishment of aeronautical engineering training in Canada might provide some interest.

†Dinner address delivered at the Annual General Meeting of the C.A.I. in Ingonish, N.S., on the 16th June, 1959.

*Assistant to the Chief Engineer

THE BEGINNINGS

Aerial Experiment Association

This celebration of the Fiftieth Anniversary of the first successful powered flight in Canada and the British Empire by a British subject, off the ice on Lake Bras d'Or at Baddeck, Nova Scotia, on February 23rd, 1909, by J. A. D. McCurdy, is in fact also a celebration of the efforts of the Aerial Experiment Association founded on October 1st, 1907, by Dr. Alexander Graham Bell at the suggestion of Mrs. Bell. The members of the association, as finally organized, were Dr. A. G. Bell, Chairman, F. W. (Casey) Baldwin, Chief Engineer, J. A. D. McCurdy, as Assistant Engineer and Treasurer, Lt. T. E. Selfridge, U.S. Army, Secretary, and Glenn Curtiss, Director of Experiments. To me, Baddeck is the Mecca of Aeronautical Engineering in Canada and should always be so regarded. There was a graciousness to life in those days which must have been stimulating to the young members of the Aerial Experiment Association under the driving force of the ingenious and inventive mind of Dr. Bell. The Aerial Experiment Association can be looked upon as the first great aviation cooperative effort between Canada and the U.S.A. which during the past 50 years has grown into world importance.

Dr. W. Rupert Turnbull

Also we must not forget W. R. Turnbull, an engineer who lived at Rothesay, N.B., who in 1902 constructed one of the first wind tunnels in North America, investigating various airfoil sections and propellers and hydrofoil supported boats. It was he who invented the variable pitch propeller, which in 1929 he sold to the Curtiss-Wright Co. in the United States and the Bristol Aeroplane Co. in England. He was in constant touch with Dr. Bell and no doubt was the instigator of Dr. Bell's and Casey Baldwin's experiments with hydrofoils for lifting boat hulls out of the water, thereby cutting down the resistance and allowing the whole hull going at high speed to be supported on the small underwater hydrofoils. World War I ended before these experiments were completed for submarine hunting but during World War II Baldwin did some very valuable work on this

for the Navy and this work is being continued by the Naval Research Establishment at Halifax.

These gentlemen are all among the World's first aeronautical engineers.

Engineering training

Before we can discuss the development of aeronautical engineering as we know it now, let us take a look at how engineering training came into existence. Originally, any type of engineering which was not military engineering was called "civil engineering". There were no Engineering Colleges as we know them until well on into the 19th century. A man articled himself to a recognized engineer and paid for the privilege of being gradually taught to be an engineer. The candidate got his basic training in mathematics and science either by reading or at his own expense for tutoring.

Gradually the demand grew for specialized training in the various fields such as mining, mechanical, electrical, chemical and metallurgical. The result was the establishment of departments at colleges devoted to training in an organized way in these individual fields.

In any further discussion, it should be kept in mind that the function of an Engineering School is to train students *to become* engineers. Then, it is the duty of industry to train the candidates *to be* engineers. There is continual pressure from industry to get more and more of their own practical processes put into an engineering curriculum. Fortunately, older experienced engineers recognize that what is really needed is more emphasis on basic mathematics, science and what we call the humanities. The developing of a habit of work in students at all levels of instruction is also of great importance. The large failure rate of first year engineering students is mainly due to lack of ability to work, which is a habit that can be cultivated.

In the organizing of Engineering Schools at Universities, there was a great deal of resistance at first as they were looked upon as Trade Schools which could not be regarded as being in the same educational class as the liberal arts courses leading to the Church, Law and Medicine. Indeed, it is well known to those who have come in contact with these affairs, that engineering students very often have to enforce on students of other faculties their right to recognition as being of first class social standing, and they are usually successful. But these conditions have gradually been changed until at present as much as one-third of all engineering training is taken up with studies in English, economics, philosophy and history.

I would like to interject a comment on the use of the term "education" in engineering. We talk a great deal these days about "education" and we try to do something about it. But at present it does not follow that the end product of any University or College is an educated person. Undergraduates certainly receive good training in skills and routine analysis but, in these days of mass production of graduates, I feel that were it not for the mixing and discussion among themselves, undergraduates would receive very little education; certainly they get little help from the teaching staff. This condition I feel will continue until we furnish enough teachers to be able to approach a tutorial system with small groups of students. I feel that engineers especially have a great need to develop cultural interests and above all, an interest in their fellow men. The slide rule and computer are great instruments; but there is more to life than their operation. There is a vast region of stimulating interest in the participation in the general affairs of those around us; and elsewhere in the world. The saying that, "The price of Freedom is eternal Vigilance" was never truer than today.

Dr. Adler, the Director of the Institute for Philosophical Research defines Education as follows: "Education tries to cultivate the humanity of man by developing his human excellences – both intellectual and moral. The ultimate goal is human happiness and the welfare of society. The ancient philosophers understood this. Specialized or vocational training was regarded by them as training for slaves, not the education of free men."

One of the prime requisites to becoming an engineer is practical experience. In the early days, the apprentice system constituted a large part of the engineering training. In England and Europe, this system is still in existence and is carried out in a definitely organized form. To a certain extent the same is true in North America where the student is expected to get experience during what are called his vacation periods; but this is a very hit-and-miss affair as the student usually takes what employment he can get which often is not connected with what he is studying. There are, of course, a few industries which have definite training courses for undergraduates and graduates and there is one institution in Canada, Waterloo College, which makes arrangements with industry to take their undergraduates for three months and then they return to study for three months, alternating this way until they receive their degrees.

DEVELOPMENT OF AERONAUTICAL ENGINEERING

First may I go back and lay a foundation upon which aeronautical engineering was built. It is a division which has come into existence during the past forty years – perhaps less than that.

Sir George Cayley, a noted scientist and engineer, in 1809-10, was the first to suggest that instead of trying to imitate bird wing flapping motion, a fixed outstretched wing should be used and that the wings should have a curved cross-section from what we now refer to as leading to trailing edge.

Then in 1843-5, Henson produced a model with Cayley's curved wing section and a tail surface shaped like a bird's tail which could be operated up and down vertically to give pitching control. In this work he was helped by Stringfellow. Henson abandoned his work in 1845 but Stringfellow continued on and produced a model with a small steam engine which actually flew. He at least showed that steam powered flight was possible.

Following this came Francis Herbert Wenham, an engineer by profession, who first suggested biplane construction as likely to give greater strength with the least weight. He also seems to be the first to suggest long narrow wings as being most efficient, recognizing the effect of what we now term aspect ratio.

In 1881, Horatio Phillips put forward the suggestion that the wings should not only be curved in chordwise cross-section but that the leading edge should be thickened. This was the beginning of modern airfoil sections. Phillips actually constructed a machine with 50 wings, 22 feet long and 1½ inches wide placed one above the other 2 inches apart like a Venetian blind. This machine weighing 420 lb had a 9 hp steam engine which with a crude propeller actually lifted from the rails on which it ran at 40 mph, being prevented from getting too far up by a system of guard rails.

Then came Sir Hiram Maxim, an engineer, who from 1890-3 carried on flying research and finally with a ponderous machine running on rails and powered with steam engines of some 600 hp managed to lift into the air a short distance against guard rails, which kept the machine from rising too high. On the last run at 40 mph the machine lifted the guard rails and crashed into a wreckage from which it was never rebuilt. These experiments cost some £20,000. Sir Hiram did, however, prove again that flight was possible, as indeed had been recognized before this. But controlled flight was still an unsolved problem.

You will notice that all these gentlemen were engineers and I suggest that they were what we would probably call mechanical engineers; although not being Army engineers, they were probably just called "engineers" or perhaps "civil engineers".

The theory of producing lift to overcome gravity was fairly well understood in these early days; but the real problem was that of providing a sufficiently light and reliable motive power.

Internal combustion engine

It was the internal combustion engine, which made its appearance in 1876, being developed from then onward in many fields such as the "horseless carriage" in the 1890's, which gave the answer to this problem; but reliability of operation was another question which took a considerable period of time to bring about. Today, powerplants are reasonably reliable, if properly maintained by experienced personnel.

Also we now have fuels of excellent quality provided we observe certain elementary precautions; but we have no idea of the difficulties encountered with fuels in the early days of flight. The gasoline was probably what was called stove gasoline which was either heavy or contained too high a percentage of water which would cause engine sputtering. This was bad enough in a motorcycle or an automobile but could easily cause a crash in an airplane. Lubricating oils were of fairly good quality but the designs for lubrication were very primitive and inadequate.

I have touched on the development of motive power from the steam engine to the internal combustion engine. It was thought at first that it was necessary to have a fly wheel on these engines. Then the suggestion was made that if the whole cylinder formation of a radial engine were made to rotate, this would eliminate any necessity for a fly wheel. The famous Gnome engine used by Farman and Blériot and others from 1911 onward with such success is the best example of this type.

In the Gnome, the fuel mixture was led from the carburetor up through a hollow crank shaft into the crank chamber. The fuel charge then went up into the piston and into the cylinder combustion chamber through an automatic valve in the head of the piston. The exhaust was made directly into the atmosphere through valves in the heads of the cylinders operated by push rods. As a result of this method of exhaust, the engine was a terrible consumer of lubricating oil, about two-thirds being blown out at the exhaust. One very good advantage was that the rotation of the engine helped to keep the cylinders cool even when the aircraft was standing still on the ground. This remarkable engine was used on many aircraft in the First World War. Of course, it is obvious to any engineer that this large rotating mass would give gyroscopic couples when the aircraft made a turn. This was indeed the case as considerable nose up or nose down effect resulted when making turns.

This Gnome engine was gradually displaced by various forms of in line engines, a number which were of the multicylinder V type.

It is interesting to note that by 1911, 99 engine types varying from 25 to 200 hp were water cooled and only 23 air cooled.

The rated altitude of most of these early engines was fairly low as the question of adjusting carburetion was not solved satisfactorily for some time.

ADAPTING THE MECHANICAL ENGINEER

It is obvious that in the search for reliable motive power, the mechanical engineer was given the problem to solve. Naturally, he continued on with the design of the whole early aircraft. The argument was based upon the fact that as an aircraft was subjected to various inertia forces and as mechanical engineers dealt with these effects in the design of moving mechanical devices and mechanisms, therefore, he was the logical engineer to design aircraft. From this to the next step that a training in mechanical engineering was necessary to design aircraft seemed logical. In the 1920's Cowley and Levy in their book on *Aeronautical Design* pointed out the fallacy of this argument. Anyone properly trained in kinematics, kinetics and statics, that is in basic mechanics, was quite capable of dealing with the inertia force problems of aircraft design. But as time went on, it became evident that more training in advanced structures and mathematics and physics to keep pace with the requirements of aerodynamics and avionics was also necessary; in other words, what was needed was training based upon advanced mathematics and physics. This is not making light of mechanical engineering training. I am merely pointing out that such training may be deficient for some of the present day requirements, as it certainly has been for a considerable period past. But I wish to emphasize the fact that there will continue to be openings in the industry for engineers from many departments of training especially if they wish to apply themselves as many have done and are doing successfully.

Out of all this grew a demand for training based upon first class courses in mathematics and physics such as given in the very best honour courses. The first class Engineering Schools in the U.S., such as MIT recognized this and established Aeronautical Engineering Depart-

ments apart from the Mechanical Engineering Departments.

University of Toronto

May I make it perfectly clear that what follows in the next few paragraphs is not put forward in any spirit of self-justification. I do apologize for having to use the first person singular so often, but I have found it is necessary because the facts are becoming obscure; and the events are being described inaccurately by hearsay.

Looking back, many of these events now appear to me highly humourous; for one can see in them the characteristics we all possess to a certain extent; namely the great care we take in accepting new things we have never seen or which we have not done ourselves. I always like the story about the man from the backwoods who when he saw a giraffe in a zoo for the first time, exclaimed, "There ain't no such animal!"

If you wish to read about real resistance to progress, look up the history of the introduction of the steam locomotive in England. One petition against allowing a certain line to be built described the dangerous speed of twelve miles per hour at which it was going to operate and how the smoke from these machines would ruin the strawberry crop. The worst thing though was that the noise would frighten the foxes and spoil the hunting! So perhaps the slow progress in the beginning of aviation is not to be wondered at. Quite lately, I saw an analysis showing that it usually takes about 15 to 20 years to introduce a new idea in the aeronautic industry!

The history of the establishment of aeronautical engineering training at the University of Toronto is interesting when we look back. The first suggestion to give aeronautical training at the University of Toronto came in 1911 from R. D. Delamere, an undergraduate of the School of Practical Science. He and a group of undergraduates built a half size model of the aircraft used by John McCurdy on his daring and history-making flight from Key West to Havana. The model was used as a decoration for an undergraduate dance. Unfortunately, all the bits and pieces seem to have disappeared. After this, Delamere went to see the Dean, Dr. John Galbraith, and suggested that a course be given to train graduates to be ready to go into the aircraft industry which Delamere and his friends saw was coming. He was told that it would be a very long time before there would be any considerable aircraft industry and that a general training such as available at the SPS was quite suitable for those days. Inside of four years, Delamere was taking flying instruction at the Curtiss Flying School managed by John McCurdy at Toronto and aircraft were being built as fast as possible. It would have been quite easy to have introduced a short course on theory of flight into the engineering course. C. H. Mitchell, the graduate who gave a paper on "Aerial Mechanical Flight" to the SPS Engineering Society in 1895, was then available in Toronto in 1911 to give the course. But here again we must not be too harsh especially with Galbraith who had battled every form of resistance to establish the School of Practical Science and finally the Faculty of Applied Science and Engineering at the University of Toronto.

During World War I, Professor J. H. Parkin constructed a small wind tunnel in which he conducted research at 37 mph speed. As a result of this work, a more pretentious wind tunnel with a speed of about 60 mph was built in 1923 with funds from the Dominion Government. In these tunnels, Professor Parkin carried out valuable research on models of that period. An option in the mechanical engineering course called "Aeronautical Engineering" was introduced by Professor Parkin in 1928 in the third and fourth years. This was operated only for one year with four third year students as Professor Parkin left to join the National Research Council in 1929 before the next session. I was then Professor of Applied Mechanics and had been asked to give some more advanced mechanics to the second year mechanical students to help them in their appreciation of aerodynamics; also my interest in flying was well known. I imagine, it was because of this that I was asked to give some lectures on aerodynamics to the four aeronautical option students left stranded in their fourth year. After giving these lectures, I formed the opinion that a very much better training in mathematics and physics would be necessary if aeronautical students were to get anywhere with aerodynamics. In the meantime, the option was cancelled. It was claimed that there was no real demand from students or graduates for the training and that was that.

In order to show that there was interest, I proceeded to offer a course of lectures on aerodynamics after hours from 5.00 to 6.00 pm during the 1930-31 session to any students who wished to come. I expected five or six but about a hundred turned up and we had to go to a large lecture room. The course began in the middle of October and ran until the end of February. The final number who stayed on was about twenty. There was no lack of interest in those who had to drop out; but as the end of the session approaches, students begin to develop a serious interest in the approaching exams and commence to spend more time in study! This information about the interest in the course when produced had no effect; so the course was given again with about the same attendance the following year; except that some of the Ontario Hydro Electric engineers took the lectures recognizing that a great deal of aerodynamic theory applies equally well to hydraulic engineering in which they were working.

About this time, a course known as "Engineering Physics" was introduced and administered by a committee of engineering and mathematics and physics representatives of which I was chairman. The entrance requirements to this course were very high and the content of mathematics and physics was that of the best honour courses in the University. There were several options in the course so at an appropriate time, I suggested an option called "Hydromechanics" on which aerodynamics is based. The content of the subjects in this option was based largely on MIT aeronautical engineering. Later this option was called "Aeronautics".

One argument against introducing the course is famous now. This objector said that a friend had flown to New York and did not get back for two weeks on account of bad weather. "This flying can never amount to anything," he concluded. One wag commented by asking if it was the weather or New York that kept him that long. Inclusion of the course in the curriculum passed by a small margin. The new engineering physics

course began in 1934 and the aeronautical option began operation in 1936 producing two graduates in 1938. Mr. Ian Hamer was a member of our first teaching staff. The courses owes a debt of gratitude to Mr. P. C. Garratt for finding summer work with pay in his De Havilland shops for the first two undergraduates. One other company offered summer work with no pay! Then to cap it all, the first graduates could not get employment with research organizations who said they weren't interested in graduates from this new fangled engineering physics course! I had to get employment for them in England through friends in the English industry, De Havilland, Hawker and Supermarine. I still have the letter from one of these first graduates who went to the Hawker Co. stating that, "They were using the methods I had taught him!" By 1945, aeronautical engineering was established as a regular department of which the President appointed me head. This was the first complete four year aeronautical engineering course in Canada and some 300 students have graduated from it and are scattered widely in the aeronautical world. I shall return to this after discussing the work and writings of some of the early aeronautical engineers.

EARLY AERONAUTICAL ENGINEERING IN CANADA

Among the first in Canada to consider the problem of aviation was C. H. Mitchell who presented a paper on "Aerial Mechanical Flight" in 1895 to the Engineering Society of the School of Practical Science, Toronto, which is the oldest engineering society in Canada, being organized in 1885. This paper is an excellent résumé of aeronautical engineering information available at that date. In comparing the available metals suitable for aircraft construction, aluminum (called aluminium in those days) is mentioned as light but having low strength compared with steel. It was pointed out, however, that certain alloys of aluminum and copper looked very promising but the problem of working this metal had not been solved! It is difficult for us to realize how recent the great advances in the use of aluminum alloys really are. C. H. Mitchell in World War I came home as Brigadier General and was Dean of the Faculty of Applied Science and Engineering at the University of Toronto from 1919 to 1941 and always was a great help in establishing aeronautical engineering.

Professor Duff, discussing this paper in 1895 said, "I know of no possible invention which would make so great a change in the life of the individual or in the customs or organization of communities as would the successful navigation of the air. The change would be so great that it is impossible to estimate its effects, and that they would be in the main beneficial is to me doubtful."

There are two other important addresses made before the Canadian Club to large audiences, one on March 1st, 1909, by Baldwin in Toronto, and the other later on March 27th, 1909, at Ottawa by Dr. Bell, which was attended by many noteworthy people but the effect on the military people was not very favourable although eventually, as we know, flights were arranged at Petawawa for the military people to observe.

The first address seems to have escaped notice over the years. I can only give a few notes from a newspaper report which relates how Casey Baldwin read a telegram from Dr. Bell dated February 24, 1909, stating, "McCurdy flew the Silver Dart one mile and a half in great style" and another dated February 25, 1909, "McCurdy succeeded in circumdroming Baddeck Bay. Covered five miles average height forty to fifty feet. It was a famous performance."

The speaker went on to say, "It now remains for aviation and the aerodrome to be reduced to a commercial basis. The desire for exhilarating sensation of high speed and the spirit of competition led to the development of the motor car. Now the same spirit is being diverted to the flying machine. Still greater, however, is the influence originating in the desire for military power and control."

There were those present who heard this address and who saw the great future of aviation and the direct results were the first air meets in Canada in July 1910 at Montreal and Toronto, organized by Mr. Ed Willcox of Toronto and his associates, Mr. Duncan MacDonald, President of the Royal Automobile Club of Canada, and Mr. William Carruthers of Montreal Tramways.

C. H. Mitchell of the Army Intelligence Service, The Corps of Guides, together with Major Percy Biggs and Captain T. C. Irving, Jr., of the II Field Company Canadian Engineers, tried to impress the Army staff with the first bombing demonstration in Canada at the second air meet in Canada on Trethewey Field near Toronto on July 10th to 13th, 1910, organized by Mr. Ed Willcox, mentioned above. A small earthwork strong point was built by the engineers and an aircraft was to fly over and the pilot drop a sand bag "bomb" on it. Several slabs of gun cotton were buried in the strong point and these were to be electrically detonated by wires led into the woods nearby. A Wright Biplane flown by Walter Brookins came along and dropped the bag when over the earthwork. The pilot had never done this before and did not allow for his own speed so that the "bomb" landed about a hundred yards past the target. The operator in the woods saw the sand bag "bomb" released and hit the ground so he fired the charge anyway. The audience roared with laughter; but the Army staff were not impressed.

Lateral control—Ailerons

It is of special note that at this air meet the Blériot machine "La Scarabee" flown by Count De Lesseps used wing warping for lateral control. It was only after Farman introduced the practical Aerial Experiment Association ailerons explained by John McCurdy that wing twisting was abandoned. I use the term "practical ailerons" to avoid any argument that moveable portions of wings for lateral control had been tried in England and Europe before this but were discarded in favour of wing warping. There is absolutely no question but that the Aerial Experiment Association ailerons were the first form of lateral control flaps which worked properly, so ably demonstrated first on Baldwin's White Wing, then on Curtiss' June Bug, and finally on John McCurdy's Silver Dart, perhaps, the most conclusive demonstration being made when John McCurdy flew a figure eight in the June Bug. And, of course, John McCurdy continued flying using these ailerons for several years, becoming a legendary figure in the aviation world.

MODERN TRAINING REQUIREMENTS

Whatever the necessity for separate Aeronautical Engineering Departments was before 1939, the present day situation makes it imperative that first class fundamental training in mathematics and science must be offered. The advances in structural requirements, supersonic aerodynamics and the electrical and electronic demands are so great that only those with this first class training can undertake and supervise fundamental design.

But I wish it understood that practical experience is something which no amount of theoretical training can replace and without which no one will get very far in the aeronautical industry. It is my opinion also that everyone who aspires to become an aeronautical engineer should have some experience with operating machine tools. I don't mean that he should become an expert machinist; but he should become familiar with what the different tools can do. This will help the young designer to avoid making what I call "draftsman's dreams".

I know that aircraft companies have training schemes whereby the young candidate spends a certain amount of time in the various departments. The Fairey Co. still has a very good apprentice course here. But, it is difficult to allow inexperienced personnel to have much to do with production work as any mistake costs time and money which is rightly condemned by Management and the Unions. Graduates of Technical Schools and Institutes of Technology come better prepared in this respect than University graduates. There has been great resistance from Unions in the past about allowing students to work. The Unions said the students could stand and watch the men work but must not help in that work. At De Havilland we now have a clause in the contract that student Engineering Trainees, as we call them, can do shop work under supervision.

We at De Havilland were not entirely satisfied with the results of rotating undergraduates in the shops during the summer vacations. In order to get better machine tool experience, we rented the machine shop of Ryerson Institute of Technology for seven 40 hour weeks. The students were given a course under expert instruction on the various machine tools and actually made certain simple fittings from drawings. At the same time, they were given a course in drafting. These students were paid their regular salary during this period. The results were excellent, judging from the appreciation of these men when later they came into the design office.

Anyone going into the aircraft industry on the engineering side and certainly on the production side should be given this training. It is in this respect that we are backward as compared with England and some free European countries with their apprentice schemes.

I think, it is fair to say that at least 75% of the detail work in aircraft engineering is done by technicians and technologists, terms which the Canadian Aeronautical Institute can take credit for having recognized. These men are the great backbone of the industry and every effort should be made to up-grade the theoretical training of these personnel to professional engineering standing if possible. Some of the best designing ability is often found among these personnel.

What constitutes a good designer? How do you determine who will make a designer? Can a designer be trained unless he has certain characteristics? These are questions I have discussed with many people. I would certainly say that a designer must have good ability to visualize objects in space and to translate this into drawings. Provided the candidate has good imagination, he can be properly trained in descriptive geometry to produce good drawings. But he must have had good practical experience so as to know what is possible. Even with all this, there must be an indefinable creative characteristic of confidence and practical sense. Creative ability is rare but is easily recognized. But when this spark is recognized, it should be encouraged and not be allowed to smoulder under a cloud of neglect, frustration and non-appreciation. I know of no class of people so responsive to the simple word of appreciation as aeronautical engineering personnel.

EARLY EXPERTS AND THEIR IDEAS

And now may I go back and review some rather disconnected information about the ideas of the early experts. When we compare the information available in those early days with the volume of data which aeronautical engineers of these days possess, one wonders how those original engineers produced controllable aircraft. It is interesting to see what information was available and to see what was written even as late as 1910. For some time, spruce was favoured over aluminum as being preferable, the strength of spruce being given as 8,000 psi and aluminum as only 16,000 psi whereas spruce only weighed 25 lb/cu ft and aluminum is given as weighing 162 lb/cu ft. Roughly, this makes aluminum 3¼ times as heavy as wood for resisting a given load. Duralumin alloy is said to have been invented in 1908 by Wilm but came very slowly into use. Mitchell, in 1895, spoke about aluminum as light but difficult to machine as already explained.

As late as 1910 there were still statements made as follows: "That in the opinion of competent experts, it is idle to look for a commercial future for the flying machine. There is and always will be a limit to its carrying capacity which will prohibit its employment for passenger or freight purposes in a wholesale or general way." Arguments such as these were usually based upon the theory that the weight varies as the cube of dimensions, whereas the supporting surface only varies as the square of the dimensions. This really does not apply exactly to an airplane. It also does not take account of speed. The statement goes on to say that: "One of these days, some mathematical genius will figure out the problem with exactitude and we will have a table giving the maximum carrying capacity of various surface areas at various speeds based upon the dimensions of the advancing edges. At present, it is a matter of guess work." This same source quotes Chanute as stating that advocates of the monoplane were probably wrong. "I believe" Chanute says, "that the future aeroplane dynamic flyer will consist of superposed surfaces" and goes on to say, "I see few objections to superimposing three, four or even five surfaces properly trussed and thus, obtaining a compact, handy, manageable and comparatively light machine." Chanute was one of the original stimulating influences in North America. Indeed, we know that the Wrights in 1900 first became interested in flying through the Chanute experiments.

As we all know, biplane construction persisted into the years of World War II. There are certainly hundreds of Flying Club members and RCAF personnel who learned to fly on the old Tiger Moth biplane. Personally, I think that those were the most enjoyable days of flying. But the monoplane also made its appearance at an early date.

The manufacturing total production of aircraft up to July 25, 1909, by other than United States plants is given as follows:

Santos Dumont	90
Blériot	200
Clemenceau Wright	80
Voisin	100
Farman	130
Antoinette	100

In the United States, Curtiss and Wright figures were unobtainable but list prices for Wright and Curtiss machines were $5,600 and $5,000 respectively. This was in the days of real money.

With our present day familiarity with high speed aircraft and missiles, it is difficult to think of speeds of 60 mph being regarded as top speed in the period 1908-11. Yet in 1910 Mr. F. W. Ronchester, in addressing the Royal Society of Arts in England, stated that, "it was difficult to see how the aeroplane could compete in the transport field unless it could exceed the automobile average speed of 25 to 35 mph. Otherwise, the aircraft would have no great advantage. Also, since some water craft were making 40 mph, it was necessary for aircraft to fly at least 60 mph for military observations purposes. A speed of 90 to 100 mph," he stated, "would change the whole situation in favour of the aeroplane."

There seems to have arisen a certain amount of confusion among those not in the industry about the meaning of the term "tricycle undercarriage". Some people seem to think that tricycle only means three wheels which is partly correct; but the term as applied to airplanes means a nose wheel and the main wheels located aft of the centre of gravity. The term, I think, arose from the similarity to the children's tricycle which had a small steerable front wheel and two large main wheels to the rear. John McCurdy's Silver Dart had a steerable tricycle undercarriage – probably the first. The three point landing gear had the main wheels forward of the centre of gravity and a small tail wheel. Some early aircraft merely had a metal skid at the rear; but these were ruled out when airports were built with paved runways, which these skids scored badly. There used to be some advantages in the old three point landing undercarriage in rough terrain. But in the many arguments I have had on the subject one which always impressed me as invalid was that it took more skill to use this form of undercarriage. Perfectly true, but it wasted more time in training. Anyone can learn very quickly to land a tricycle undercarriage.

There are other interesting side lights which even in 1911 caused some anxiety to those engaged in commercial flying exhibitions. The rights of aviators to fly anywhere in space was looked upon as a definite right at first; but apparently this was not correct. According to the eminent legal authorities, Blackstone, Littleton and Coke, called the "Fathers of the Law", the owner of realty holds title above and below the surface. The theory was accepted without question by the courts of those early days. The document concerned points out that it was almost impossible in those days to catch an offender who flew over your property. There were no registration numbers on the aircraft so that a ground observer could report a pilot for trespassing! But one suggestion offered I am certain will cause amusement today. It was suggested that airships should only fly over and follow public highways; and aeroplanes, if flying at lower levels at night, should carry a red light to port and a green light to starboard with a white head light.

These rules were copied from France; but an improvement which was suggested for daylight flying was that some form of warning signal should be carried such as a horn, whistle or bell! I dare say many of us can remember wishing we had a horn to warn people and dogs off the old grass runways when we were gliding in to land! Just to close this topic, a case was quoted where a Justice of the Peace in New Jersey painted a sign on his roof warning aviators to keep off his domain, that is, not to fly over his home! After fifty years of flying, we are back worrying about airways and space rights again!

Finally, let us take another look at the aerodynamic situation in those early aircraft. The importance of the position of the centre of gravity was known but how to get stability took a considerable amount of experimenting to arrive at any conclusions. Dihedral for lateral stability was realized quite early but the relation of wing area to tail area and location relative to the cg in giving longitudinal stability was only slightly understood by 1912. The early aircraft had elevators and horizontal stabilizers well out in front and there might be a tailplane at the rear of the fuselage. The correct positioning of these elevators is in itself a story of experimental research during which the adventurous designers and pilots risked their lives.

The general theory of stability was published by Bryan in 1911; but I doubt whether any early designers ever referred to this work or even knew about it. I am informed by W/C Hartman that a project is under way to try and calculate the longitudinal stability of the model Silver Dart flown by him on February 23, 1959.

Trick flying or aerobatics was well advanced by 1913. An amusing incident was related to me the other day by Mr. Hunter of De Havilland about training for "looping the loop". A pilot would strap himself into a chair and have the chair pulled up into the air with the pilot upside down for a short period of time. This was supposed to condition the pilot to being upside down while making the loop! I dare say, centrifugal force did not exist in those days. The operation of coming out of a spin was not discovered until late in 1915 or early in 1916.

A/V/M E. W. Stedman

Perhaps, the first person to be recognized as an aeronautical engineer in Canada was the late Air Vice Marshal E. W. Stedman, whose memoirs are being published serially in the magazine *Canadian Aviation* and which later on will be published in book form by the University of Toronto Press. He came to Canada as the engineer in charge of the Handley Page aeroplane which was to try the Atlantic crossing for the London Daily Mail prize of £10,000. This aircraft, one of many built near

the end of World War I, was a four engined biplane with a wing span of 126 ft and was to have been used to bomb Berlin. But Alcock and Brown, in a twin-engined Vickers Vimy, took off from Newfoundland on June 14th, 1919, and completed the trans-Atlantic journey successfully and thus won the prize.

Stedman had attended the Royal College of Science for three years and a fourth year in civil and mechanical engineering at the City Guild College. He had a wealth of practical experience both through his work in the National Physical Laboratory in England and as Chief Engineer of the Handley Page Company and his service with the Royal Naval Air Service in France during World War I. When the Air Board was formed in Canada, he was appointed Director of the Technical Branch on October 30, 1920. It was due to his efforts that definite regulations were drawn up governing the design of aircraft.

On the organization of the RCAF in 1924, Stedman joined and during World War II rose to the rank of Air Vice Marshal, his last post before retirement in 1946 being Air Member for Research and Development. During this period, he was the first to suggest the formation of an organization to investigate jet propulsion. It was his idea, based on experience during World War II, that Canada should have personnel trained in powerplant design, operation and maintenance; and his opinion was that jet propulsion was the coming powerplant for aircraft. The final outcome of this as we all know is the magnificent record of the Avro/Orenda jet propulsion powerplants.

After retiring from the RCAF in 1946, A/V/M Stedman was appointed to the Engineering Department of Carleton College, Ottawa. He was one of the moving spirits in bringing about what is now an expanding new centre of Canadian education. He was a great believer in proper first class training in mathematics and science for aeronautical engineers. His passing in 1957 was a great loss.

J. A. Wilson

We must also mention the late Mr. J. A. Wilson, Director of Civil Aviation, who helped us a great deal in establishing the course in aeronautical engineering. It was largely through his efforts that we started a three year diploma course called "Aerial Navigation" to train young men to become transport pilots. He obtained for us the Link trainer in Canada on which to give flying instruction. TCA also used this machine to check out their pilots. This course was discontinued after World War II as there were plenty of pilots available from the Service.

CONCLUSION

In 1935, I spent some time in English, French and German aviation centres and on my return, gave an address to the Royal Canadian Institute on aviation. In conclusion, I stated that in the near future we would be able to fly to Winnipeg and back on a long summer day and also would be able to fly to London and back over the weekend. The audience was very polite in their amusement and my better half told me afterward at home that I should stop boasting about this flying business.

Times have changed. High speed has taken over. Missiles have been shot past the moon. Travel across the continent of North America can be made in a few hours, and it is not only possible to spend a weekend in London; but business could be conducted in London after having breakfast on this side of the Atlantic and return from London in time for dinner. But this is not the end. Speeds of 1,000 mph on commercial air liners are not impossible. Indeed, Mach 3 airliners are being discussed. VTOL and STOL aircraft designs are producing practical aircraft. But the great advance is not far off – the nuclear-powered aircraft.

Institute of Aerophysics

Whatever the difficulties of the past may have been in gaining recognition of the necessity for training in aeronautical engineering, the present and future are bright. Aeronautical engineering training in Canada is now on a firm basis. It is always the duty of those in authority in education to see to it that coming along under them are personnel capable of taking over and continuing to make progress. In this respect, we were fortunate at the University of Toronto. In 1935 a young man "came out of the west" to take a post graduate course in aerodynamics. We were so struck by his originality and will to work that we kept track of him and eventually in 1945 inveigled him back with us as Professor of Aerodynamics. The story of his original shock tube investigations of supersonic speeds is one of persistence with little available equipment in a room about 10 × 20 ft. Out of this, he eventually formed the Institute of Aerophysics with its magnificent laboratories and outstanding staff. The numerous contributions of papers on all phases of supersonic investigations have made the Institute known throughout the aeronautical and scientific world.

Students now enter in the engineering physics course and then in the third year go into the aeronautical option and on to aeronautical engineering in a fifth post-graduate year. The cycle has come around a full turn as the engineering world has gradually seen the great value of engineering physics training for this and all types of engineering. For all this great advance, we owe a tribute to our President, Dr. Gordon Patterson.

THE COMPRESSIVE INSTABILITY OF A HYDRAULIC JACK†

by E. Kosko*

National Research Council

SUMMARY

The buckling of a hydraulic jack is analyzed on the basis of a new concept, that of partly overlapping stiffnesses, believed to be more rational than previous approaches. General formulas are derived and numerical results are presented in the form of design charts. The effects of inelastic material behaviour, of transverse loads and of initial imperfections are also considered. A similar method for undercarriage shock-absorber struts is indicated. The conclusion stresses the necessity of an experimental investigation.

INTRODUCTION

THE hydraulic jack is one of the most universally adopted components of hydraulic systems and as such has found widespread application in automatic and semi-automatic mechanisms. In aircraft and in missiles the operation of powered flight controls, of landing gear retraction and of many other devices relies mostly on hydraulic jacks.

Such a jack is usually required to carry either a tensile or a compressive load. In the latter case, the question of structural stability arises, much like for any slender column or strut. For an efficient design this is a problem of great importance, yet it does not seem that a satisfactory solution has been presented. An authoritative manual[1] has nothing better to offer than a rule of thumb. The author knows of only one attempt at a rational approach, contained in Hoblit's paper[2] on which Forray's design charts[3] are based. As pointed out in Reference 4 Hoblit's model is still not up to the mark, as it may lead to unconservative results.

In the first section of this paper, various idealizations of a typical jack are reviewed and assessed as to how they account for compressive instability. The concept of *overlapping stiffnesses* is put forth as one which reproduces the essential features while permitting mathematical treatment without undue complications.

In a further section, as a result of the analysis, a transcendental equation is derived, the lowest root of which yields the critical load of the idealized jack. A direct solution being impractical, charts have been prepared from which the critical load can be easily determined for a wide range of geometrical and stiffness parameters.

The method of overlapping stiffnesses lends itself to extensions in several directions. It can be applied, at the cost of additional labour, to more complicated configurations, such as piston rods or cylinders with stepwise variation of stiffness, double pistons, and many others. Inelastic material behaviour due to stresses exceeding the yield value can be taken into account. Finally the effects of transverse loading and of initial imperfections, i.e. the beam-column problem, can be treated by using the same approach.

SYMBOLS

a, b, d, l	(in)—lengths of the various segments of the jack, as defined in Figure 1.
A	(in²)—cross-sectional area
A, B, D, F, G, H	indeterminate constants appearing in Eqs. (1), (3), (5) and (6)
E	(lb in⁻²)—Young's modulus of elasticity
I	(in⁴)—moment of inertia of cross section
L	(in)—total length of jack between lug centres
M	(inch lb)—bending moment (positive when increasing the curvature)
M, N	auxiliary quantities (see 'Discussion of buckling conditions' and 'The rigid cylinder')
P	(lb)—compressive load
x	(in)—lengthwise coordinate
y	(in)—ordinate of the deflected elastic line
α	(in⁻¹)—axial-load parameter, defined by $\alpha^2 = P/EI$
$\beta = \alpha_1/\alpha_2$	stiffness-ratio parameter ($\beta^2 = EI_2/EI_1$)
$\mu = \alpha L/\pi$	nondimensional buckling parameter for complete jack

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σ	(lb in^{-2})—stress per unit area
ρ	(in)—minimum radius of gyration of cross section
ϕ	magnification factor

Subscripts

1, 3	refer to cylinder
2, 4	refer to piston rod
0	refers to condition without axial load
cr	critical

Prime effective (also derivative)

THE IDEALIZED JACK

A typical jack, as represented in Figure 1, consists in the main of a cylinder, a double-acting piston equipped with sealing rings, a piston rod, and a gland which seals the passage of the piston rod through the cylinder end. The free ends of the cylinder and of the piston are usually shaped as lugs and provided with bushings or anti-friction bearings.

When a compressive load is applied through the end lugs, one may expect the jack to behave on the whole as an Euler column. Under the assumptions of small deflections and of elastic beam theory, there is a critical value of the load at which the originally straight shape becomes unstable and a deflected shape is possible. With the same assumptions, when a transverse load is acting, or in the presence of initial imperfections (such as eccentricity in the application of the axial load, misalignment, diametral clearances at piston and gland), the bending effects are magnified by the compressive load. When the latter approaches its critical value, bending moments and deflections theoretically tend to become infinite. In practice, before this happens, stresses in some regions will have exceeded the proportional limit of the material, and the column will fail in buckling.

However, even within the limitations of elastic theory, there are appreciable differences between an idealized jack and an Euler column, some of which make difficult the calculation of the critical load. The main differences have been pointed out in Reference 2:

(a) The axial load is transmitted over part of the cylinder length through fluid pressure;

(b) The cross section of the jack is not constant, but varies stepwise along the length;

(c) The shape of the deflected centre line does not vary continuously over the length of the column. A relative rotation may take place between piston rod and gland, and between piston and cylinder.

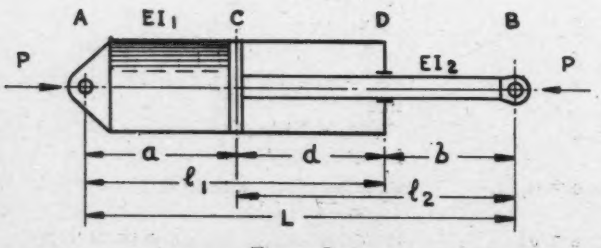

Figure 1
Idealized hydraulic jack

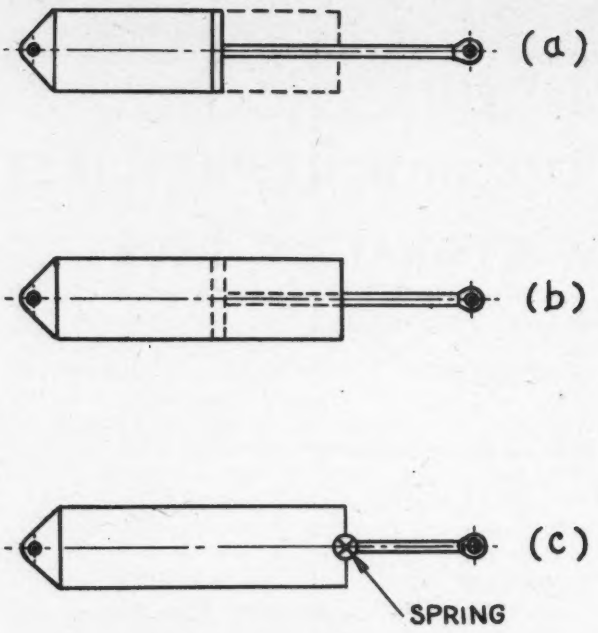

Figure 2
Alternative mechanical models
(a) and (b) stepped columns
(c) Spring-jointed column

The fluid column

The first point above has been adequately discussed by Hoblit who shows that from the point of view of buckling behaviour there is no difference between a fluid column and a solid one having the same bending rigidity. There may be a secondary effect in the inelastic range due to a change in Young's modulus when the hoop stress in the cylinder reaches a high value; this is of little practical significance.

The substitute stepped column

It has often been suggested that critical loads for hydraulic jacks be evaluated as for stepped columns. Formulas and charts for this type of column can be found in Reference 5 and in many textbooks[6, 7]. The substitute column is taken as consisting of two uniform segments, one 'thick' and one 'thin', with bending stiffnesses equal to those of the cylinder and of the piston rod, respectively. The question remains, what length is to be assigned to these segments, as the cylinder and the piston actually overlap over the portion CD. If the thick part is taken to be of the length a, and the thin part is taken to be as long as the piston rod (Figure 2(a)), the resulting critical load is likely to be on the conservative side. On the other hand, taking a stiffness EI_1 over the full length of the cylinder, and EI_2 over segment b only, (Figure 2(b)) tends to underestimate the buckling load.

The substitute stepped columns thus yield an upper and a lower bound for the critical load, but this result may not be accurate enough for an efficient design.

If the maximum compressive load occurs when the jack is fully extended, the stepped column model should give a good estimate of the critical load, providing a tight fit at the piston and at the gland.

The spring-jointed column

This approach, suggested by Hoblit[2], considers the jack as composed of the full-length cylinder and of the outside portion of the piston rod, the two connected by a rotary spring (Figure 2(c)). The spring provides a restoring couple proportional to the angular deflection of the rod relative to the cylinder; the spring stiffness is taken equal to the restraint provided by the inside portion of the rod, simply supported at the piston and at the gland. These assumptions lead to the establishment of a transcendental equation for the critical load. The solution is then found by trial and error.

Although more refined than the stepped column assumption, Hoblit's theory still appears to be somewhat arbitrary. First of all, the cylinder is assumed to carry the axial load over its whole length, while actually between points C and D the load is transmitted through the rod. The destabilizing effect which this may have on the remaining parts is thus neglected. On the other hand, the part of the cylinder which overlaps the piston rod should not be considered capable of buckling, as no axial stress is present. On the whole, the spring-column model tends to overestimate the critical load, and this error becomes more marked as the relative length of the overlapping portion increases.

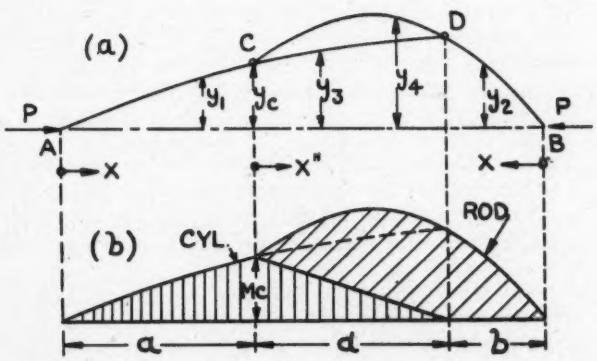

Figure 3

(a) Assumed buckled shape

(b) Bending moment diagrams for cylinder and rod

Column with partly overlapping stiffnesses

A better representation of the physical behaviour of the compressed jack is achieved by considering its shape in a buckled condition, while the stresses still remain in the elastic range. The deflected centre line is shown (much out of scale) in Figure 3(a). With only the axial load acting, the bending moment at any station is proportional to the deflection; it is thus possible to represent the bending moments by the diagram of Figure 3(b). The outstanding feature of this approach is that the deflected centre lines of the cylinder and of the piston rod do not coincide in the overlapping portion.

The various assumptions made and the mathematical analysis of such a composite column are presented in the following section.

CALCULATION OF CRITICAL LOAD

Assumptions

(a) The cylinder and the piston rod have uniform section and material properties over their entire lengths; their section centroids are initially perfectly aligned.

(b) Up to the critical load the stresses nowhere exceed the proportional limit of the material.

(c) The cylinder and the piston rod each have uniform section properties over their entire length.

(d) At the piston and at the gland, the piston rod is free to rotate with respect to the cylinder; at these points, no diametral clearances are allowed for. In other words, pin connections are assumed at the four points, A, B, C and D (Figure 1).

(e) The axial load is carried by the piston rod over its whole length, and by the cylinder over portion AC. As shown by Hoblit, this assumption is practically equivalent to that of a fluid column.

(f) Effects of shear forces and of hoop stresses can be neglected.

Analysis

As is usual in column analysis, a deflected shape of the centre line is assumed so as to satisfy the differential equation of the small-deflection elastic beam theory. This equation in its general form reads

$$EI\frac{d^2y}{dx^2} + M(x) = 0$$

In the case of a compressive load, the bending moment $M(x)$ is equal to the product of that load P by the deflection y, plus the moment due to whatever transverse loading may be present. For the various segments of the structure appropriate expressions are substituted for the bending moment, in accordance with Figure 3(b). The indeterminate constants which occur in the solution are so adjusted that the deflections and slopes of the various segments are made compatible at the points C and D. We shall now consider each of the four segments in turn.

Segment AC of cylinder

According to assumption (a), no bending moment is transmitted through the lug at point A. The deflection is therefore expressed as for a pin-jointed column by

$$y_1 = A \cdot \sin \alpha_1 x \qquad (1)$$

the origin of the abscissa x being taken at A, and the axial load parameter α_1 defined by

$$\alpha_1^2 = P/EI_1 \qquad (2)$$

Segment BD of rod

This also deflects as a portion of a pin-jointed column

$$y_2 = B \cdot \sin \alpha_2 x' \qquad (3)$$

The x' coordinate is counted from point B as origin, and the axial load parameter α_2 is defined by

$$\alpha_2^2 = P/EI_2 \qquad (4)$$

Segment CD of cylinder

If the piston rod had a large diametral clearance in the gland at D, this portion of the cylinder would tend to remain straight with the same slope as at point C. The effect of bearing pressure at the gland is to constrain the cylinder to bend, by virtue of a transverse force applied at D. This force is equal to M_c/d, where

$M_c = Py_c$ is the bending moment acting on the deflected cylinder at point C. At a station distant x'' from C, the bending moment is thus

$$M_3 = Py_c(d - x'')/d$$

as for a cantilever built-in at C. The deflection for this part is given by

$$y_3 = \frac{y_c}{d} \cdot a_1^2 \left[D + Fx'' - \frac{1}{6}(d - x'')^3 \right] \tag{5}$$

where D and F are arbitrary constants.

Segment CD of rod

By similar reasoning, this portion acts as a cantilever built-in at D with an initial slope equal to the final slope of segment BD. The transverse load M_c/d is equal and opposite to that acting on the cylinder, causing a transverse bending moment $M_4 = -M_3$. The rod is also subjected to the axial load P; the differential equation therefore reads

$$EI_2 \frac{d^2y}{dx^2} + Py = Py_c(d - x'')/d$$

The deflection is obtained by integration:

$$y_4 = G \sin a_2x'' + H \cos a_2x'' + y_c(d - x'')/d \tag{6}$$

Eqs. (1), (3), (5) and (6) represent the deflections of the four segments under consideration. These expressions contain seven arbitrary constants A, B, D, F, G, H and y_c which must now be adjusted to make the deformations compatible. The end conditions at points A and B are automatically satisfied by the expressions (1) and (3) for $x = 0$ and $x' = 0$, respectively.

At point C ($x = a$ and $x'' = 0$), the deflections of the rod and of both segments of the cylinder must coincide, i.e. $y_1 = y_3 = y_4 = y_c$, or

$$\begin{aligned} y_c &= A \sin a_1a \\ &= a_1^2 y_c \left(D - \frac{d^3}{6} \right) \Big/ d \\ &= H + y_c \end{aligned} \tag{7}$$

Also, on either side of point C, the cylinder centre line must have the same slope, i.e. $y_1' = y_3'$, or

$$Aa_1 \cos a_1a = a_1^2 y_c \left(F + \frac{d^2}{2} \right) \Big/ d \tag{8}$$

From the four relations (7) and (8), the constants A, D, F, and H may be eliminated; we find

$$A = y_c \cdot \operatorname{cosec} a_1a; \qquad D = \frac{d}{a_1^2} + \frac{d^3}{6};$$

$$F = \frac{d}{a_1} \cot a_1a - \frac{d^2}{2} \qquad H = 0$$

Similarly, at point D($x' = b$, $x'' = d$), the deflections of both rod segments and that of the cylinder must match, i.e. $y_2 = y_3 = y_4$, or, substituting the values of the constants just determined,

$$\begin{aligned} B \cdot \sin a_2b &= y_c \left[1 - \frac{(a_1d)^2}{3} + a_1d \cdot \cot a_1a \right] \\ &= G \cdot \sin a_2d \end{aligned} \tag{9}$$

Making the slopes of the rod centre line equal on both sides of point D, we obtain

$$Ba_2 \cdot \cos a_2b = \frac{y_c}{d} - Ga_2 \cdot \cos a_2d \tag{10}$$

Eqs. (9) and (10) represent three homogeneous linear relations between the three constants B, G and y_c. These constants, and therefore the deflection at any point, can be different from zero only if the determinant of the coefficients vanishes. This condition can be written

$$\left[1 - \frac{(a_1d)^2}{3} + a_1d \cdot \cot a_1a \right] \cdot a_2d \,(\cot a_2d + \cot a_2b) = 1 \tag{11}$$

We have thus obtained the required buckling condition which the compressive load P (or its functions α_1 and α_2) must satisfy in order that a deflected equilibrium configuration may exist. Eq. (11) plays the same part for the hydraulic jack as the simpler relation $\sin \alpha L = 0$ plays for the pin-ended uniform column: it is the basis for the determination of the critical load at which an unstable deflected shape, different from the straight one, becomes possible.

Discussion of buckling condition

The transcendental Eq. (11) from which the critical load is to be calculated is not easy to solve when the dimensions of the jack are considered as given. Three independent parameters are involved (α_1a, α_2b, and α_1d — or α_2d), and a trial-and-error solution would be very laborious. An indirect method has been used instead.

Let the ratio of the stiffnesses of rod and cylinder cross sections be denoted by β^2 (generally <1)

$$\beta = (EI_2/EI_1)^{1/2} = a_1/a_2. \tag{12}$$

Next, for the nondimensional parameter α_1d (taken as an angle in radians), assume a series of values between 0 and π. Calculate the auxiliary quantity $M = 1 - (\alpha_1d)^2/3$ as well as $\alpha_2d = \alpha_1d/\beta$ and $\cot \alpha_2d$.

For each of the above values of α_1d assume a series of values for α_1a (also in radians), varying from 0 to approximately $\pi - \alpha_1d$ determine $\cot \alpha_1a$. Calculate the auxiliary quantity $N = \alpha_2d\,(M + \alpha_1d \cot \alpha_1a)$, and $\cot \alpha_2b = 1/N - \cot \alpha_2d$. From this latter, the angle α_2b is obtained, and $\alpha_1b = \alpha_2b.\beta$.

The buckling parameter μ_1 is then, for each assumed α_1d and α_1a

$$\mu_1 = \frac{a_1L}{\pi} = (a_1a + a_1d + a_1b)/\pi, \tag{13}$$

the sum of three known angles. The buckling load is

$$P_{cr} = \mu_1^2 \frac{\pi^2 EI_1}{L^2}. \tag{14}$$

By using the parameter α_2 instead of α_1, the result could have been presented in terms of the second buckling parameter,

$$P_{cr} = \mu_2^2 \frac{\pi^2 EI_2}{L^2}. \tag{14a}$$

The geometric configuration which corresponds to these assumed values of α_1d and α_1a is characterized by the proportion

$$a:d:b:L = a_1a:a_1d:a_1b:\pi\mu_1 \tag{15}$$

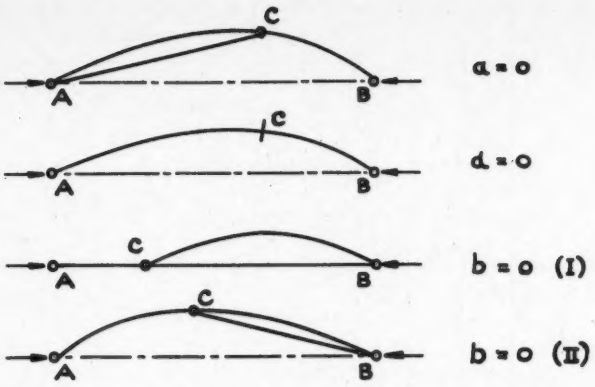

Figure 4
Layout of design charts

The indirect method thus yields a buckling load and a geometric configuration associated with a pair of assumed values.

These calculations have been performed with an accuracy of four decimal places for a large number of assumed parameters. The tables which include the numerical results are not published here as charts seem to be preferable for practical applications. The construction of these charts is explained in a subsequent section.

Limiting cases

Much light is thrown upon the buckling criterion Eq. (11) by considering special cases in which some of the dimensions are made equal to zero (Figure 4). Although the physical realization of these cases may not always be possible, their mathematical meaning is quite obvious.

Case $a = 0$

The first factor on the left-hand side of Eq. (11) becomes infinitely large. For the product to be finite, the second factor must vanish, i.e. $\cot \alpha_2 b + \cot \alpha_2 d = 0$. This means that the angles $\alpha_2 b$ and $\alpha_2 d$ must be supplementary, and hence $\alpha_2 L = \alpha_2 b + \alpha_2 d = \pi$, or $\mu_2 = 1$. The buckling load is

$$P_{cr} = \frac{\pi^2 E I_2}{L^2} \tag{16}$$

This means that the piston rod (which in this case extends over the whole length, $l_2 = L$) buckles as a pin-ended Euler column, without any support from the cylinder – a fairly obvious interpretation.

Case $d = 0$

Considering that at the limit $\alpha_2 d = 0$ the expression $\alpha_2 d \cot \alpha_2 d$ tends to unity, Eq. (11) becomes

$$[1 + \alpha_1 d \,.\, \cot \alpha_1 a]\,[1 + \alpha_2 d \,.\, \cot \alpha_2 b] = 1$$

which simplifies into

$$\alpha_1 \,.\, \cot \alpha_1 a + \alpha_2 \cot \alpha_2 b = 0 \tag{17}$$

This represents, as it should, the buckling condition for a stepped column.

Case $b = 0$

Here, Eq. (11) has two types of solution, each of them corresponding to a different mode of buckling. One of the solutions is

(i) $$\alpha_2 d = \pi \tag{18}$$

This represents the buckling of the piston rod as an Euler column. The parameter $\alpha_1 a$ may assume any value between 0 and approximately $\pi - \alpha_1 d$. The second buckling parameter is

$$\mu_2 = \alpha_2 L/\pi = L/d = \frac{1}{1 - a/L}$$

and the buckling load may be obtained from Eq. (14a).

The alternative solution is the one in which the first factor on the left-hand of Eq. (11) is made to vanish, yielding

(ii) $$\cot \alpha_1 a = \frac{\alpha_1 d}{3} - \frac{1}{\alpha_1 d} \tag{19}$$

This solution represents the buckling of the cylinder of length $l_1 = L$ simply supported at its ends and subjected to an axial load acting over a partial length a. The value of μ_1 which satisfies Eq. (19) is obviously independent of the stiffness ratio β.

Of these two alternative solutions the practically important one is that which corresponds to a lower buckling load.

The rigid cylinder

It will also be useful to consider what happens if, for a rod of given stiffness EI_2 and for a jack of given geometric configuration $a : b : d : L$, the stiffness of the cylinder is increased beyond all limits so that the ratio β approaches zero. In this case, the equations under the heading 'Analysis' must be appropriately modified by letting $\alpha_1 = 0$. Eq. (11) then becomes

$$\alpha d \,.\, \left(1 + \frac{\alpha d}{\alpha a}\right) \,.\, (\cot \alpha b + \cot \alpha d) = 1 \tag{20}$$

where α stands for α_2. The same result may be found by taking as deflected shape of the cylinder centre line a straight line

$$y_1 = y_3 = A'x \tag{21}$$

over both segments AC and CD. This expression replaces then Eqs. (1) and (5), while the deflection of the rod is still described by Eqs. (3) and (6). The buckling Eq. (20) is obtained again by eliminating the arbitrary constants.

The method for solving this transcendental equation is the same as described in 'Discussion of buckling conditions'. For a range of values of αd and αa, the auxiliary quantity

$$N = \alpha d \left(1 + \frac{\alpha d}{\alpha a}\right)$$

is first calculated, from which

$$\cot \alpha b = \frac{1}{N} - \cot \alpha d$$

The second buckling parameter is then as before

$$\mu_2 = (\alpha a + \alpha d + \alpha b)/\pi,$$

and the buckling load is given by Eq. (14a).

For values of a/L approaching unity, μ_2 tends to infinity: this is what would be expected for a rigid column.

Let us now briefly consider the various limiting cases.

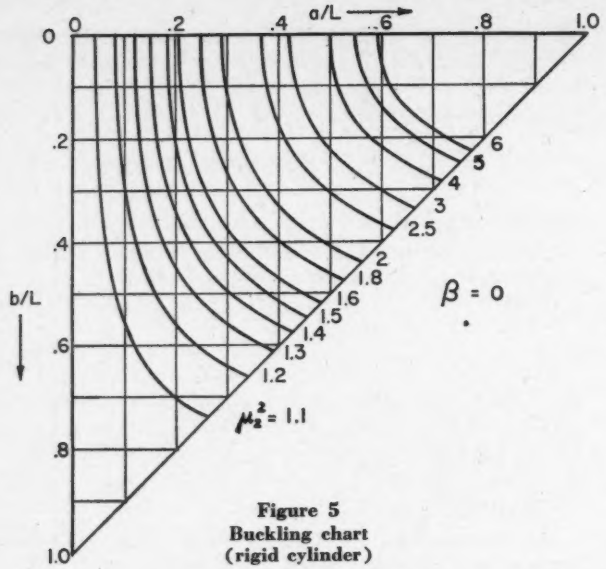

Figure 5
Buckling chart
(rigid cylinder)

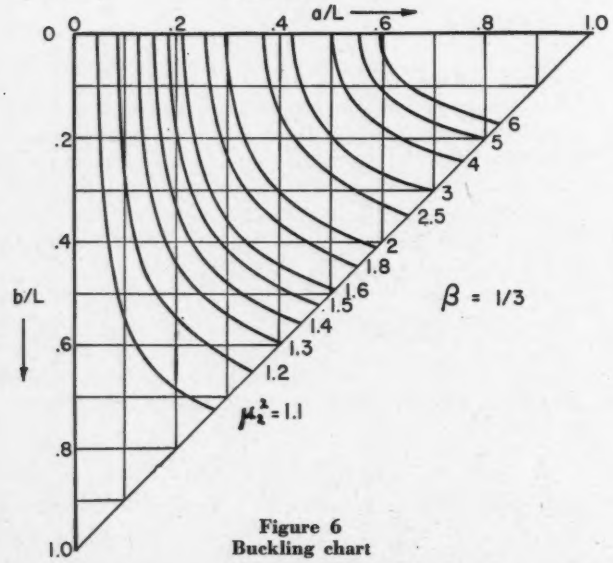

Figure 6
Buckling chart

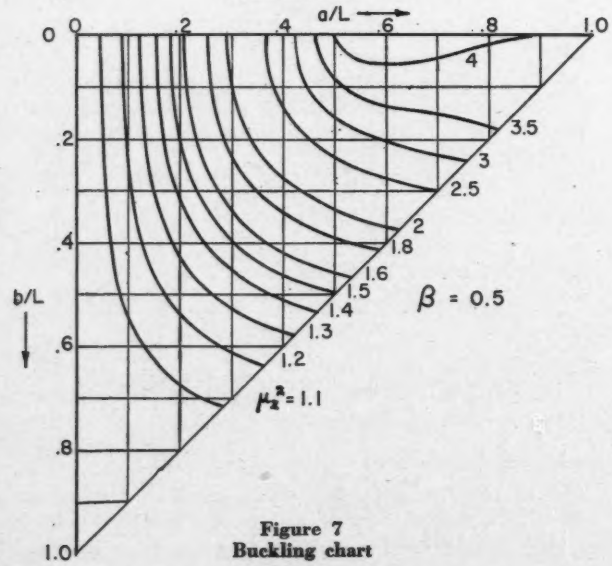

Figure 7
Buckling chart

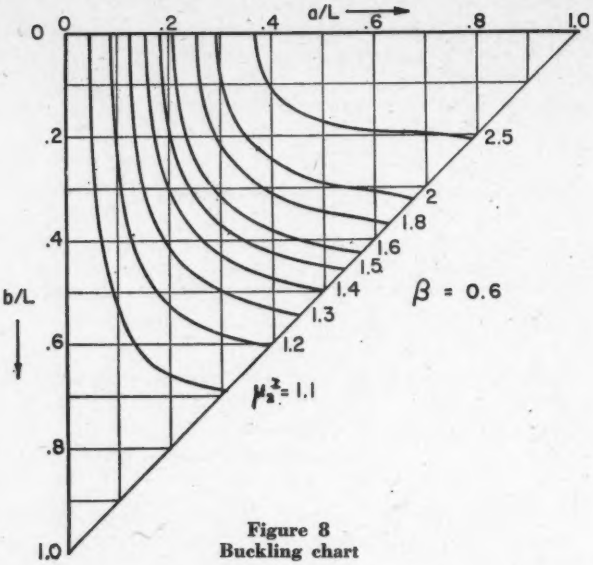

Figure 8
Buckling chart

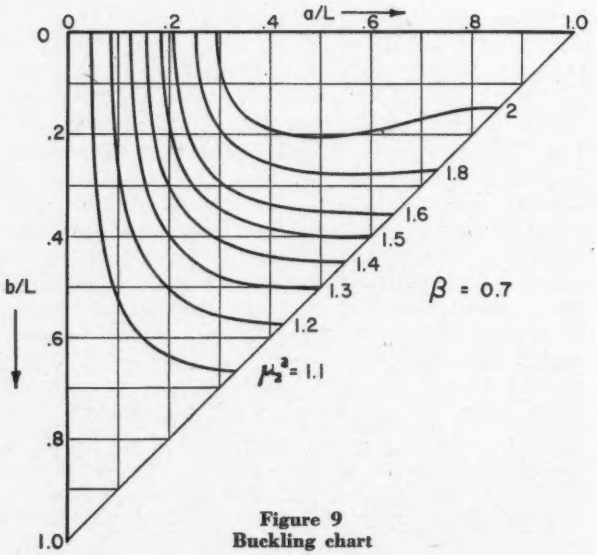

Figure 9
Buckling chart

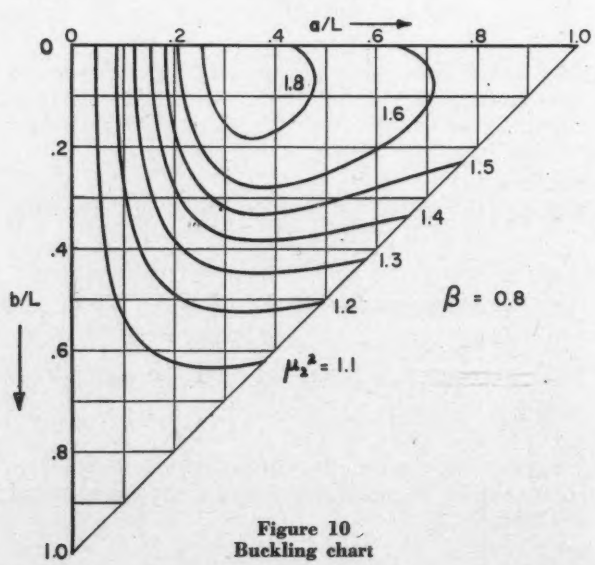

Figure 10
Buckling chart

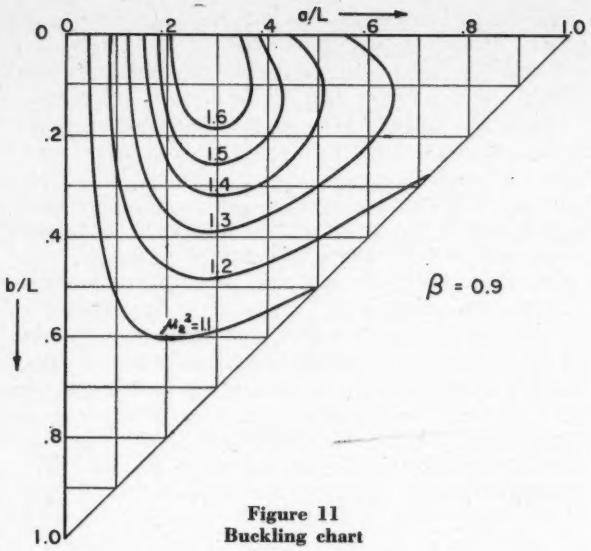

Figure 11
Buckling chart

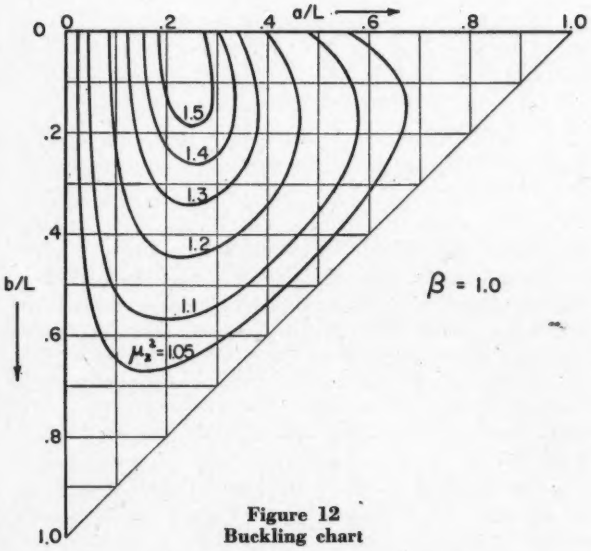

Figure 12
Buckling chart

Case $a = 0$
The solution is $\mu_2 = 1$ which again represents buckling of the piston rod over its full length.

Case $d = 0$
With $\alpha d.\cot \alpha d \rightarrow 1$, Eq. (20) becomes

$$\left(1 + \frac{\alpha d}{\alpha a}\right)(1 + \alpha d \,.\, \cot \alpha b) = 1$$

which may be simplified to

$$\frac{1}{\alpha a} + \cot \alpha b = 0 \qquad (22)$$

This is the correct buckling equation for a stepped column having one segment infinitely stiff.

Case $b = 0$
The only solution is $\alpha d = \pi$ i.e., the rod buckles as an Euler column over its length BC. Any positive value of αa is acceptable herewith.

NUMERICAL RESULTS

Presentation of results

Charts have been prepared (Figures 5 to 12) for eight values of the stiffness ratio β ranging from 0 to 1. Each chart covers the complete range of values of the ratios a/L, b/L and d/L, showing contours of constant squared buckling parameters μ_2^2 (or μ_1^2). A point P within the triangle OAB (Figure 13) represents a set of ratios a/L, b/L and d/L, each between 0 and 1, such that

$$a/L + b/L + d/L = 1$$

The distances PP_1, PP_2, and PP_3 from the base lines OA, OB and AB represent respectively a/L, b/L, and d/L. Points on the hypotenuse AB represent the jack in its fully extended configuration ($d = 0$).

For any given geometry, the buckling parameter is obtained from the chart by interpolation, and the buckling load is calculated by means of Eq. (14) or (14a). It will be noted that the squared parameter is equal to the ratio

$$P_{cr}/P_1 = \mu_1^2, \qquad (23)$$

where P_{cr} is the critical load of our jack, and $P_1 = \dfrac{\pi^2 E I_1}{L^2}$ is the Euler load of a uniform pin-ended column of equal length L, having a flexural rigidity equal to that of the cylinder cross section. If, instead of the cylinder, the piston rod is taken as a basis for comparison, the same relation applies provided the subscript '1' is replaced by '2'.

On the other hand, a reduced length L' may be defined as the length of a uniform pin-ended substitute column which has a bending rigidity equal to that of the cylinder cross section and a buckling load equal to that of the given jack,

$$P_{cr} = \frac{\pi^2 E I_1}{(L_1')^2}$$

By comparison with Eq. (14) we have

$$L_1' = L/\mu_1$$

and similarly

$$L_2' = L/\mu_2 \qquad (24)$$

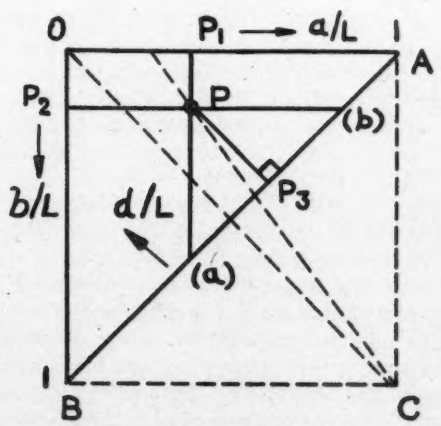

Figure 13
Buckling models in limiting cases

One advantage of the type of triangular chart presented here lies in the possibility of easily finding the points which represent a given jack in various stages of retraction. Their locus is a straight line going through the point C ($a/L = 1$, $b/L = 1$). This follows from the proportion

$$\left(1 - \frac{a}{L}\right) : \left(1 - \frac{b}{L}\right) = l_2 : l_1. \tag{25}$$

This ratio remains constant for a jack having a cylinder of length l_1 and a piston rod of length l_2, independent of the overlap length d. In particular, jacks having equal lengths of rod and cylinder are represented by the centre line OC. Naturally, allowance must be made for changes in total length, which may be expressed as $L = l_1 + l_2 - d$.

Discussion of results

For almost all values of the stiffness ratio, the charts follow a similar pattern. There is a general increase in the buckling parameter μ_2^2 from the value 1 at the left-hand side of the triangle ($a = 0$) to $1/\beta^2$ in the upper right-hand corner A. The change along the hypotenuse BA (Figure 13) is a continuous one and corresponds to that of a stepped column. Along the upper side of the triangle, however, the variation is discontinuous: values of μ_2^2 increase from both ends toward a peak point at which the two Eqs. (18) and (19) have a common root. The three sides of our triangle correspond to the limiting cases $a = 0$, $d = 0$, and $b = 0$, discussed earlier. Once the values of μ_2^2 are established at the boundaries, it is relatively easy to complete the chart by adding as many inside points as warranted.

In practice, the difference in length between cylinder and piston rod is not large as a rule. The most important portion of the chart, therefore, lies around the centre line ($a = b$).

As regards the effect of varying the stiffness ratio while keeping constant the geometrical data, this is best seen by cross-plotting μ_2^2 vs β. It may be concluded that for a given rod stiffness an increase in cylinder stiffness (i.e. a reduction in β) can produce only a limited increase in the buckling load; the maximum increase is attained for a rigid cylinder ($\beta = 0$).

At the other end of the scale, the case $\beta = 1$ represents a design in which a thick plunger has the same stiffness as the cylinder ($EI_1 = EI_2$). Here, there is no variation in μ_2^2 along the hypotenuse, as the stepped column reduces to a uniform one, and $\mu_1 = \mu_2 = 1$. However, with retracted plunger, the increase in critical load due to overlapping stiffnesses may reach 70%.

Comparison with other methods

We are now in a position to compare our results with those obtained by the various assumptions discussed in the section headed 'The Idealized Jack'.

The substitute stepped columns of Figures 2(a) and 2(b) are represented on our chart (Figure 13) by the points (a) and (b), respectively. These points are obtained by tracing through P a vertical and a horizontal, respectively, and intersecting them with AB. From our numerical data it appears that the buckling parameter at (a) is always less than at P; hence, as already stated, substitution of the stepped column of Figure 2(a) is always conservative. For the other substitute (Figure 2(b)), no general conclusion is possible; in most cases, especially for small β, the substitution overestimates the critical load.

Spot checks have been made in order to compare Hoblit's spring-jointed column with the present work; numerical results were taken from Reference 3. For small amounts of overlap d, the differences are quite small. This is due to the fact that, for $d = 0$, both methods reduce to the same stepped column (Eq. (17)). Larger differences have been observed for greater overlaps, showing the spring-jointed model to be unconservative.

There does not seem to be any valid reason for applying Hoblit's model to the calculation of jack buckling loads. Not only are the results on the unsafe side, but the labour of obtaining numerical results is about of the same order as with the present method. In fact, the buckling equation derived on the spring-jointed column assumption can be written in our notation

$$a_1 \cdot \cot a_1(a + d) + a_2 \cot a_2 b = \frac{1}{3} a_2^2 d$$

In the case of a rigid cylinder this equation becomes

$$\frac{1}{a(a + d)} + \cot ab = \frac{1}{3} ad$$

In the limiting case $d = 0$, these equations reduce, as they should, to those for the stepped column, Eqs. (17) and (22).

INELASTIC MATERIAL BEHAVIOUR

In the preceding sections our considerations have been limited to the long-column range in assuming that up to the critical value of P the stresses nowhere exceed the proportional limit. For reasons of weight economy, an efficient design will normally fall in the intermediate or even short column range. It is necessary then to take into account the effect of a variation in Young's modulus.

The standard approach, for a uniform column, is that of the reduced modulus theory: Euler's equation is assumed to be valid in the form

$$\sigma_{cr} = \frac{\pi^2 E'}{(L'/\rho)^2} \tag{26}$$

where L' is an effective length, ρ the minimum cross-sectional radius of gyration, and E' an effective modulus of elasticity in compression, usually taken as a function of the average compressive stress P/A. As shown by Shanley, and confirmed by many tests, the effective modulus may be taken as approximately equal to the tangent modulus of the material, at least for reasonably stable cross sections. Somewhat more conservative results are obtained by using empirical curves such as the various parabolic curves recommended in ANC-5.

In a column of variable cross section, and in particular in a stepped column, Eq. (26) loses its meaning. The assumption of an effective modulus on the basis of the highest P/A stress, i.e. of the smallest cross section, will obviously underestimate the buckling load. Moreover, in the case of a fluid column, the walls of the cylinder do not actually carry any compressive stress; it would not be justified to assume here any reduction in

modulus. As pointed out before, there may be some change in the compressive modulus due to high hoop tension stresses in the walls, but this effect can probably be neglected.

It is therefore suggested that the reduction in modulus be applied to the piston rod only. The reduction will in turn affect the stiffness ratio parameter, and the solution may now require several trial-and-error steps. The following method enables one to shorten these calculations.

First, for the given geometrical configuration of the jack, determine a plot of μ_2^2 vs β, starting at least from an initial value $\beta_o = (EI_2/EI_1)^{1/2}$, with unreduced E_2, and extending to lower values of β as far as necessary. Next, calculate and plot as a function of β the auxiliary quantity

$$\sigma_2/E_2' = [\mu_2\pi/(L/\rho_2)]^2 \qquad (27)$$

On the other hand, from the known or assumed variation of the reduced modulus with compressive stress, we may regard both σ_2/E'_2 and the parameter $\beta = \beta_o\sqrt{E_2'/E_2}$ as functions of the stress $\sigma_2 = P/A_2$. A curve can now be plotted in the same graph as for Eq. (27) representing this variation of σ_2/E'_2 with β. The intersection of the two curves yields a value of β and one of σ_2/E'_2, from which the critical stress and the critical load are easily obtained.

EFFECT OF TRANSVERSE LOADING AND OF INITIAL IMPERFECTIONS

The ideal column, as described earlier, will not deflect when subjected to an axial load until that load reaches its critical value. In real columns, some deviations always exist. The centroids of the cross sections may not be perfectly aligned with the lug centres; friction in the bearings, play or elasticity at the gland or at the piston may produce offsets; finally, loads such as inertia or gravity may act in a direction transverse to the jack axis. All these circumstances result in bending moments. Those due to transverse loading exist even when there is no axial load, while those due to initial deviations and offsets grow with P. As a rule, the increase in the bending moment is more than proportional to P; this can be seen on the product $P.y$ where the second factor is an increasing function of P.

Any particular case of initial imperfection or of transverse loading can be analyzed by substituting the proper expression for the bending moment into the differential equation which governs the deflection of the column. These additional terms will appear in Eqs. (1), (3), (5) and (6). The conditions for compatible deflections and slopes – Eqs. (7) to (10) – are not homogeneous any more in the constants A, B etc, and it now becomes possible to obtain a non-zero solution for these constants. Each solution will contain in the denominator the determinant Δ of the system of equations; when the value of that determinant approaches zero, the constants – and therefore the deflections and the bending moments – grow beyond all limits. But the equation $\Delta = 0$ is equivalent to our buckling condition Eq. (11), and is satisfied when the load attains its critical value. In other words, when the axial load approaches the value calculated from Eq. (11), we may expect the effects of transverse loading or of initial imperfections to be magnified beyond all limits.

In practice, for a pin-ended column, the effects just discussed are generally of a secondary nature. It will be sufficient, in most cases, to use one of the approximate formulas which give the effect of axial load as a magnification factor ϕ by which initial bending moments should be multiplied. Either the secant formula, with

$$\phi = \sec\left[\frac{\pi}{2}\sqrt{P/P_{cr}}\right]$$

or Perry's approximation (less conservative)

$$\phi = \frac{1}{1 - P/P_{cr}}$$

may be used. If M_o represents either an initial bending moment which exists when $P = 0$, or a moment $P.e$ resulting from an initial offset e, or a combination of both, then under the influence of the axial load P the bending moment becomes

$$M = \phi \,.\, M_o$$

The formula should not be applied to the end portions of the column.

CONCLUDING REMARKS

In many special designs, the idealization of Figure 1 may appear an oversimplification. But even in such cases, the concept of partly overlapping stiffnesses, when properly applied, should lead to better results than the blind application of stepped-column formulas. Certainly, in many instances the maximum compressive load occurs when the jack is fully extended, and then there is no overlap of stiffnesses. In all other cases, and for more conventional shapes, the method outlined here should give satisfactory results.

Regarding the freedom of rotation of the piston rod relative to the cylinder, either a perfect or an elastic fixation at the piston and at the gland could have been assumed. This would tend slightly to increase the critical load, but the resulting equations would become considerably more complicated and difficult to solve. In view of the uncertainty in the actual amount of fixation, it was thought safer to rely on the assumption of free rotation.

Finally, mention may be made of another application of the method of overlapping stiffnesses. Cantilever shock-absorber struts used in aeroplane undercarriages have been treated by similar means. A buckling equation, similar to Eq. (11), has been derived for a simple cantilever configuration, and from the present solutions of Eq. (11) solutions for the cantilever strut can be easily obtained. In this problem, however, transverse loads cannot be considered as secondary, and a complete analysis of the deflections must be undertaken in each case.

Now that a rational approach has permitted to clarify the main factors which affect the instability of a compressed jack, it would be highly desirable to undertake a systematic series of tests with a view to assessing the value of the various assumptions underlying the analysis. In particular, the effects of clearance and elasticity at the gland and at the piston deserve a thorough investigation.

ACKNOWLEDGMENT

The method described in this paper was first publicly presented by the author in a short note[4]. The results have since been extended to cover a fairly complete range of numerical data.

The present paper was prepared while the author was Scientific Consultant and Special Lecturer at the Institute of Aerophysics, University of Toronto. Sincere thanks are due to Professor G. N. Patterson, Director of the Institute, for his support, and to Professor B. Etkin for his interest in this publication.

The author also wishes to thank Avro Aircraft Limited for permission to publish this paper.

The opinions herein expressed are entirely those of the author.

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CORRIGENDUM

ESTIMATION OF AIRCRAFT FATIGUE LIFE

In the June 1959 issue of the Journal (p 210), there are two typographical errors in Equations (23) and (24).

Equation (23) should read:

$$\frac{d\Delta}{df} = \frac{2.3KA}{2b^2}(f-a)^2 \exp\left[-2.3\,(KAf+B)\right] \qquad (23)$$

Equation (24) should read:

$$\Delta_m = \frac{2.3KA}{2b^2}\int_a^\infty (f-a)^2 \exp\left[-2.3\,(KAf+B)\right] df \qquad (24)$$

It should be noted that the above errors are only simple typing omissions and will not affect any final answers.

Montreal, P.Q. E. Aubrey

GUIDANCE AND CONTROL†

by D. Bogdanoff*

Canadair Limited

INTRODUCTION

THE subject of guidance and control is a vast one and, in the time I have, I shall only attempt a very general coverage of the major missile problems and advantages of various systems. The approach to the problems of guidance and control differs radically between those missiles whose time is spent within the atmosphere and those which are active for the greater part of their working life in space. I intend to treat these two types of missile separately and will begin by considering the problems of guidance and control of missiles within the earth's atmosphere, limiting this part of the discussion to air-to-air and ground-to-air missiles.

ATMOSPHERIC MISSILES

Guidance

Since the task of such missiles is to collide with a target in the air, the type of flight path is of primary importance. There are a number of courses the missile may steer in order to collide with the target, i.e. line of sight, pure pursuit, lead pursuit, constant bearing and proportional navigation[1]. Each of these types of course has its advantages and disadvantages and any of them can be used with the guidance systems I shall discuss (with one exception). The ideal course is a collision course during which the missile will pull minimum g, and the above types of navigation approximate this to a greater or lesser degree.

For most tactical situations the pure pursuit is furthest from the ideal and proportional navigation comes the closest. The guidance systems which I will consider are command guidance, beam rider guidance, and homing guidance of the passive, semi-active and active types[2].

Command Guidance

In a command guidance system the guidance intelligence is transmitted to the missile from a remote source, usually the launch site (Figure 1). Here both the missile and target will be acquired and tracked and departures of the missile from a chosen interception course will be computed, and steering signals transmitted to the missile to return it to this course. With this system the bulk of the complex equipment is located at the launch site, which allows for a more sophisticated computer. The missile electronics comprise only a command receiver, and stabilization and control equipment. For this reason the missile is fairly simple. However, this type of guidance suffers in general from low traffic-handling capacity, as the computer can in general handle only one interception problem at a time. The accuracy of this system decreases with range, as the monitoring of the missile-target motion occurs at the launch site, and the system is vulnerable to interference from similar systems in the neighborhood and to ECM.

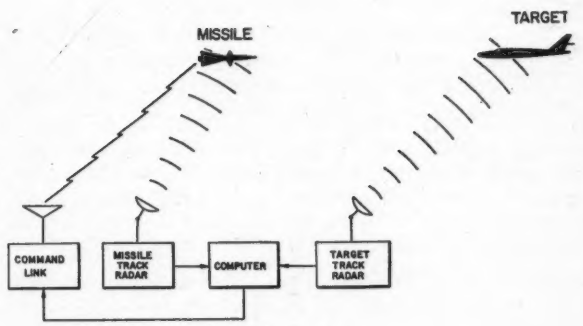

Figure 1
Generalized radar track command system

Beam Rider Guidance

Beam rider guidance (Figure 2) directs the missile along a radar beam which is made to follow the target. The system is simpler than command guidance as only

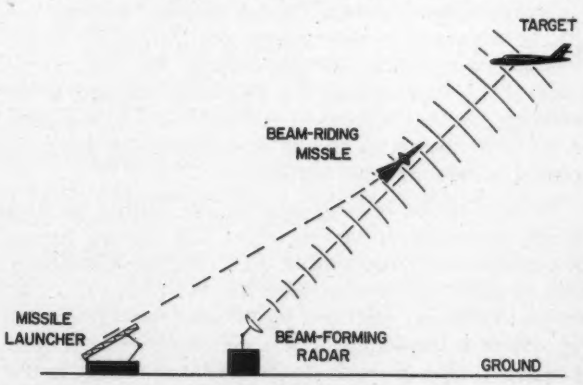

Figure 2
Beam-riding system

†Paper read at the First Meeting of the Astronautics Section of the C.A.I. in Ottawa on 9th October, 1958.

*Supervisor of Technical Services, Special Weapons Division

one tracking radar is required and computer requirements are less severe. With this system more than one missile can be guided simultaneously. Interference of the system by adjacent systems or by ECM is less likely than in the command system. Disadvantages of the system are that a very high accuracy is required in directing the radar beam, and the equipment carried by the missile is quite complex. The main design problem lies in detecting the departures of the missile from the beam and superimposing on the beam the guidance information of error amplitude and error direction.

Homing Guidance

A homing guidance system is characterized by the presence of a self-contained mechanism in the missile which obtains information from some distinguishing characteristic of the target and uses this information to steer the missile onto an interception course.

In a passive homing system the missile makes use of energy emanating from the target. Systems in this class generally make use of electro-magnetic sources of energy, such as light, heat or airborne radar.

The receiver must be capable of detecting and tracking onto this energy source and, hence, the system requires a sensitive element, a focusing device and a scanning device. This guidance system requires the least equipment amongst the class of homing missiles. It possesses the advantages that signal strength increases with decreasing range and ECM action is limited to the provision of alternative sources of energy in the required form. However, the system may be made useless in adverse weather conditions, or when the energy emission of the target does not differ sufficiently from that of the background.

An active homing system is characterized by the presence in the missile of both the transmitter of the illuminating energy and the receiver of the reflecting energy. In a small missile it is practically impossible to achieve a physical separation of the receiver and transmitter and, hence, electrical separation of outgoing and incoming signals must be achieved. To avoid feeding transmitter energy directly into the receiver it is more practical to employ pulse rather than continuous wave radar. As the missile can operate quite independently once lock-on has been obtained, the launch aircraft is free to break off the attack as soon as the missile has been launched. However, the active homing systems are limited at present to short ranges due principally to the limitation on antenna size imposed by the size of the missile. This type of missile is inherently complex as the whole guidance and control system must be contained in it. This factor makes the achievement of good reliability a very difficult problem.

In semi-active homing systems the missile receives energy reflecting from the target, this energy having been transmitted from some source other than the missile, such as the launch site or launcher aircraft. The range can be more easily increased than that of the active homing system as size limitations are no longer so rigid. The semi-active type of system lends itself well for use in the final phase interception for a missile guided by command or beam-riding in the midcourse phase.

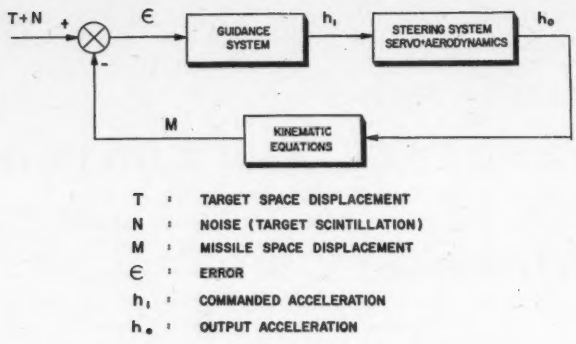

Figure 3

Overall missile loop

Control

The guidance systems which I have considered all produce signals proportional to the errors in the missile flight path. It is the function of the control system to convert these error signals into missile accelerations in such a way that the flight errors are removed and to provide stability of the overall loop. The control and guidance systems are both part of the overall system loop, which also includes autopilot, the airframe and its aerodynamic responses (Figure 3). In this paper the guidance system has been treated separately, and the other parts of the overall loop are treated here under the general heading of control. In general, the accelerations are produced by movement of surfaces on the airframe to produce unbalanced aerodynamic forces. The autopilot stabilizes the missile and modifies the control surface movements against variations of altitude and Mach number. The design must take account of the charteristics of all parts of the loop and the final design will always be a compromise. For short range missiles of the air-to-air and ground-to-air type the thrust is not usually controlled. These missiles are classified as of the boost-glide type, and the boost period is only a small part of the total flight time.

In this part of the paper I shall consider only control methods using movement of aerodynamic surfaces to produce accelerations. These movements will be initiated by hydraulic, pneumatic or electric actuators fed from signals from the autopilot. A missile may have either a cruciform arrangement of control surfaces or it may be designed with wings and tail unit as in conventional aircraft. In the case of the missile with aircraft type wings, the large accelerations required by the guidance can only be achieved normal to these wings. This means that the missile has to be rolled into a position where the required acceleration is normal to the wings before correction can take place and, hence, this type of control is known as "twist and steer".

If the roll signal is acted on prior to the acceleration signal, delays will occur in the response of the system and may lead to instability. If the roll signal and acceleration signal occur simultaneously, an acceleration will occur in a direction other than that desired and this may result in the missile barrelling. In either event, the net result will be to increase the miss-distance and may cause the target to be lost completely. For comparatively slow speed missiles these factors will be of

less importance, and this type of control is used in the the Chance Vought Regulus, a ground-to-ground missile[3].

Most fast response air-to-air missiles use a cruciform layout, where lateral accelerations are obtained by the use of two independent steering systems, in the yaw and pitch planes respectively. Acceleration commands are resolved into the two directions to produce the required maneuvers. Roll control is generally included, either to obtain accurate roll positioning, required in beam-rider systems, or to keep roll rates below a level where interaction might take place between the two steering planes.

The location and type of control surface varies widely among missiles, the choice depending on the control characteristic required for a particular missile.

Trailing edge control surfaces, similar to those of a conventional aircraft, are quite adequate at subsonic speeds, but with thin supersonic wings there may be a design problem in the location of the hinge axis and an aeroelastic problem. Moreover, the surface efficiency will change with Mach number.

Moving wing tips can provide an efficient roll control, due to the large moment arm available, but the mechanical design can be very difficult.

Tail fin control has very low torque requirements, but the delay between command and acceleration may be high due to the time required to build up the angle of attack.

Canard control produces generally linear aerodynamic response, but requires bigger stabilizing wings to counteract the effect of control surfaces well forward of the center of gravity. Also a similar time lag occurs between the command and acceleration, as happens in the tail fin case.

The fastest control can be obtained using all-moving wings, and this system also has the advantage in that the wing contributes lift. The disadvantages of this system are that the aerodynamic responses are highly non-linear for large angles of attack, with resulting gap effects, the aerodynamic coupling produces large roll rates and the large torques involved require high power hydraulic actuators.

The autopilot (Figure 4) must be designed to produce the required control surface deflections to satisfy the command acceleration, and must also contain any necessary damping, feedback circuits or smoothing circuits to eliminate resonances and procure stability[4].

The aerodynamic transfer functions have usually two lightly damped natural modes, a low frequency phugoid mode, which can generally be dealt with by the guidance system, and a high frequency (1-5cps) 'weathercock' mode which has to be damped out artificially. This requires that the control system be designed with a rate gyro feedback of high gain around the weathercock frequency. Aeroelastic resonances may be troublesome, and the first body bending mode of the Sparrow, for example, is around 30 cps. This requires that the body bending frequency be filtered in the outputs of the rate gyro and accelerometer. Finally a high gain acceleration feedback should regulate the acceleration output transfer function from dc to the weathercock frequency.

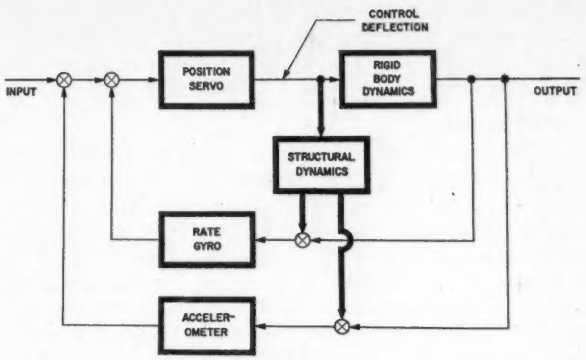

Figure 4
Typical control system

SPACE FLIGHT

I have tried to cover the characteristics and problems associated with the guidance and control of missiles in the atmosphere, and these problems must be only too familiar to many of my audience. I shall now attempt to give a similar coverage for missiles in space.

Guidance

The practice of space flight at present writing is confined to ballistic missiles and satellites with their launching vehicles. The basic problem of guidance and control for these two cases is very similar. A missile outside the earth's atmosphere but within its gravitational field is influenced only by forces due to its own motor thrust and to gravity. Its future trajectory can be accurately calculated knowing its velocity and position in space at any instant. Hence the navigational problem for both ballistic missiles and satellite vehicles is reduced to establishing the missile upon such a path that at motor cut-off the velocity, in magnitude and direction, and its position in space are such as will give it the required ballistic trajectory.

In the case of a ballistic missile it can be seen that there is an infinity of combinations of velocity and spatial position at motor cut-off which will result in a hit on a specified target. However a limitation on this choice is imposed by the fuel capacity of the missile, which requires that a near optimum trajectory should be chosen for minimum fuel consumption. For a satellite vehicle the choice is even more limited, and only one cut-off velocity for each position in a narrow band will establish the satellite exactly in a predetermined orbit. In most cases it is not necessary to define the orbit rigidly and, in practice, the tolerances on flight path for the two cases are found to be quite similar. This has meant that the navigation equipment developed for ballistic missiles has been sufficiently accurate to be used for a satellite vehicle.

Therefore we can see that the basic information required for guidance is the missile velocity vector and its spatial position during the period of boost flight. This controlled portion of the flight will last for between 3 and 8 minutes. This information may be obtained from an inertial system contained within the missile, or from a command guidance system using continuous wave or pulse radar based on the ground.

The control will consist of altering the direction and magnitude of the motor thrust and will not make use of aerodynamic forces on control surfaces as do missiles operating in the atmosphere.

Inertial Guidance

The inertial guidance system measures accelerations along the three axes of a cartesian system, orientated in space by means of a gyro-stabilized platform, and by double integration derives the velocities and displacements along each of these three axes (Figure 5). This information is fed into a computer which produces signals for steering the missile along a suitable trajectory and for cutting off the motor when the velocity attains a certain value. The Thor IRBM is an example of the all inertial system of guidance[3].

The Thor system employs three liquid-floated integrating gyros mounted on a 3-gimbal space stabilized platform. Three pendulus integrating gyros perform the function of integrating accelerometers, providing output signals proportional to missile velocity along each of the three major axes. These velocity signals are integrated in an analog computer to provide signals proportional to the missile displacement along each axis. The velocity and displacements are continually compared with those of an idealized trajectory, and steering signals are computed and fed to the missile autopilot.

The Thor system weighs between 500 and 1000 lb. As the duration of guided flight is small, gyro drift and other component errors are of less consequence than in inertial systems designed for cruise missiles, whose controlled flight may last for many hours. However the requirements are still sufficiently difficult to meet, gyro drifts of 1 ft/sec and integrator accuracies of 5 parts in 10^5 being required to produce velocity information accurate to 2 fps in 20,000 fps.

It is probable that later systems will use a digital computer to achieve greater accuracies and more sophistication within the space allotted. At present these computers are not popular due to the poor reliability of tubes and transistors and the complexity of fault finding.

Command Guidance

Command guidance using pulse or Doppler radar has many advantages, the principal one being that the computer is now transferred to the launch site and can be made larger, more reliable and sophisticated and, hence, more accurate. The Atlas ICBM has this type of guidance, using a combination of Doppler radar to measure velocities and pulse radar for tracking the missile[5]. By this means the use of integrators or differentiators is not required, and the attendant penalties of drift and noise avoided.

A Burroughs digital computer is used to solve the guidance problem and a command link system is used to transmit acceleration commands to the missile. Due to ground reflection the precision tracking radar cannot be used for the first few seconds of flight and a gyro-stabilized autopilot is used to guide the missile during this phase, and to stabilize the missile throughout the boost phase.

With this system the Atlas is claimed to have accuracy more than 3 times better than contemporary inertial systems and, by saving the weight of the guidance system, should have a significantly improved useful load to weight ratio.

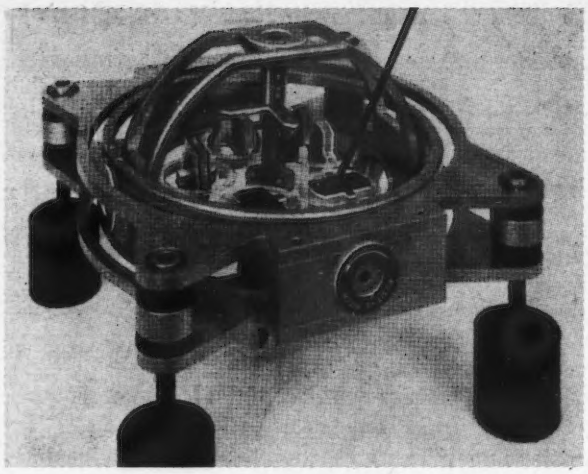

Figure 5
Inertial guidance platform

The disadvantages of the command systems are that large, expensive and permanent launch sites are required, the system lends itself to enemy jamming, and only one missile can be launched at a time from any one site.

Looking into the future, it seems likely that components for inertial systems will be developed with improved accuracy and digital computers will be made more reliable, enabling greater sophistication to be achieved. If these developments come to pass it is likely that inertial systems will gain a monoply in the ICBM field, while the command systems might still show advantages for launching satellite vehicles.

Control

In the critical phase of the boost flight, when steering is required, the missile is outside the earth's atmosphere. Hence it is impossible to accelerate the missile by using conventional aerodynamic control surfaces. The only means of producing an acceleration in space is by using reaction, and this may be done either by altering the direction of the main motor thrust, to give a component of thrust in the desired direction, or by using small auxiliary steering rockets. Both methods are used on current ICBM's or IRBM's, and the main motor on several of these large missiles is mounted in gimbals to allow its being used in this manner for steering.

The other important control problem lies in cutting off the motor thrust at the correct instant. A liquid fuel motor will continue giving thrust after the fuel supply has been cut off, due to residual fuel left in the combustion chamber. For this reason, small "vernier" rockets may be added which may be used to make final adjustments to the missile velocity after the main motor has been cut off.

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TECHNICAL FORUM

MAN-POWERED FLIGHT

(We publish below some correspondence between Dr. M. G. Whillans, Assistant Chief Scientist and Director of Bio-sciences Research, Defence Research Board, and Dr. Brian Hocking, Professor of Entomology, University of Alberta. This correspondence may be of interest to members and we invite further comment on the subject. – Sec.)

LETTER DATED THE 31st MARCH, 1959, FROM DR. WHILLANS TO DR. HOCKING

As part of general reading on the possibilities of man-powered flight, I have become interested in some aspects of insect flight.

There is a Committee on Man-Powered Flight, based at Farnborough which has been actively studying the problem of man-powered flight. Knowing your qualifications both as an engineer and as an entomologist, I am taking this opportunity to ask your help in answering the following questions:

(a) What aerodynamic advantages, if any, do hairs, bristles, setae on insect wings provide? I can see the advantages of the soft trailing edges on mosquito wings, but why the palisade of hairs on the leading edges?

(b) For low speed manned flight, could any adaptation of the haltere principle be profitable?

(c) Do you have any views about the most promising wing configuration for man-powered flight? I am wondering particularly about the advantages of the dragonfly type of arrangement as compared with that of the Diptera.

(d) Why are insects not streamlined?

Please consider this as an informal inquiry having no great priority. I hope to discuss the subject formally during my visit overseas next month, with the group at Farnborough. I would be pleased to exchange views with you when we meet again. I may say that Ian Lindsay has done a good deal to educate me. He assures me that my questions are not foolish ones.

LETTER DATED THE 6th APRIL, 1959, FROM DR. HOCKING TO DR. WHILLANS

Very many thanks for your DO letter of 31 March. I was surprised to learn of the interest in man-powered flight. This is a thing that has always intrigued me and which I have, in an amateurish way, given quite a bit of thought to.

With regard to your specific inquiries:

(a) the hairs, bristles, etc, on insect wings have been discussed recently by G. A. Horridge (*Nature* 1956, 178: 1334). His theory is that they serve to break up the laminar flow over the wing and create a zone of turbulence. Just what the significance of this is I have never quite been able to understand, but it agrees with von Holst's view (In Holst and Kuchemann 1942, *J. R. Aero. Soc.* 46: 39-56) "teeth, hairs and bristles along the anterior edge break up laminar flow and prevent loss of lift." More recently, Wolbarsht (Wolbarsht and Dethier 1958, *J. Gen. Physiol.* 42: 393-412) has discovered that some at least of the hairs on the leading edges are sense organs which have chemoreceptive and mechanoreceptive properties. He makes the plausible suggestion that they may serve to compare air velocities above and below the wing, and hence assess lift and perhaps mediate the control of stroke pattern. This sort of information must be of considerable importance to the flying insect.

(b) I doubt whether the haltere principle would have much application in low power, low speed flight. Among insects, it is of course, almost confined to those showing, for insects, high power, high speed flight. I would suppose its most likely application to be in pilotless flight where the control of yaw could perhaps be handled in this way.

(c) I would be rather skeptical of the possibility of applying the flapping flight principle to man-powered flight, mainly because the frequency of wing beat on the human scale would have to be so low as to make control precarious. It is possible however, that this could be overcome in other ways. For fixed wing flight the dipterous design would seem to me to be more promising than the odonatan. I presume you know von Holst's work with ornithopter (more properly entomopter!) models (*Ibid*, above and *Jb. dtsch. Luftforsch.* 1942) which were based on dragonflies. The only work I know of on these lines going on now is that of Fitz Patrick in New York, none of it I think published. It is interesting to note that von Holst seems more optimistic on man-powered flight than most participants in the controversy on this during the 19th century. There seem to me to be two possible approaches; firstly through the glider – perhaps promising; secondly through

a rotor system – I have done a little calculating on this, and frankly the results are not encouraging.

(d) I think most insects are not streamlined because they are not primarily interested in high speed flight, rather in hovering, manoeuverability, and sometimes range. Those that are interested in high speed flight, e.g. predators and ectoparasitic Diptera, do show a measure of streamlining both in their bodily structure and in the manner in which the appendages are carried.

I am most interested in this subject and would be glad to hear something of the results of your discussions in due course. I wonder whether you will be in Ottawa early in May when perhaps we can discuss this further.

THE CANADIAN AIR CARRIER INDUSTRY

A summary of a talk by R. Turner, President of TransAir Ltd., delivered before the Winnipeg Branch on the 9th June, 1959.

MR. Turner opened his address by outlining the rapid growth of the civil air carrier industry in Canada. He cited the Dominion Bureau of Statistics statement that "there was no discernible civil air carrier industry in Canada before 1946". The Statistics Bureau show that in this relatively short span, the industry has now become "big business".

Aircraft miles flown in Canada during 1939 were under 11,000,000; in 1947 they reached 36,032,569; by 1957 (the last year for which DBS figures are available) the revenue miles flown had reached 104,699,140.

The growth of investment in the carrier industry, in terms of assets of all companies reporting, rose from 44.4 million dollars in 1947 to 181.4 million dollars in 1957. Of this latter amount, TCA accounted for 91 million and CPAL for 34.5 million dollars and all other carriers for 55.9 million dollars.

The importance of the industry to the Canadian economy generally in terms of employment and payroll is indicated by comparing the 5,872 employees in the industry in 1947 with the 16,632 in 1957, with the corresponding growth in annual payroll from 13.7 million dollars to 78.3 million dollars in the same period.

The intangible benefits to the economy are hard to assess. However, with the expansion of exploration and development of the North, there are now literally hundreds of settlements and posts which depend solely upon the airplane for survival, and continuous expansion can only be carried out if supported by a healthy air carrier industry. The DEW line and Mid-Canada defence line projects had proved to be a mixed blessing insofar as the smaller carriers were concerned. During the time of these projects a number of companies with limited or no previous experience in the operation of Group "A" aircraft were given an opportunity to get into this type of operation on a large scale. On the other hand, the severe contraction in overall flying requirements, resulting from the termination of the construction phase of the DEW line, had left many carriers with major problems in finding utilization for large aircraft for which there is a very limited charter demand in Canada.

The conditions and requirements which had caused the rapid growth of the air carrier industry had now created problems of great magnitude, particularly with reference to carriers other than TCA and CPAL. On the basis of DBS financial reports for 1957 and 1958, a very serious financial situation is facing all other carriers. In 1957, the entire industry made an operating income of approximately $600,000.00 on gross revenue exceeding $190,000,000.00. In 1959, the accumulative summary of the monthly reports for the year added up to an overall loss of $2,122,076.00. As it is known that TCA's profits for 1958 were more than $500,000.00, the loss for private enterprise companies for the year would seem to be of serious proportions. Without naming individual companies, Mr. Turner cited the following DBS report on individual results for the operations in the year 1958: $117,000.00 loss; $2,364,000.00 loss; $892,000.00 loss; $544,000.00 profit; $122,000.00 loss; $160,000.00 loss; $548,000.00 profit (TCA). On the basis of gross revenues, the carriers under Group "B" heading category on the DBS reports showed cumulative profit of $77,000.00, whereas companies grouped in the "C" class showed a loss of $98,000.00. As the overall revenues of the entire industry would doubtless approximate $200,000,000.00, a very serious situation is depicted when one considers the deterioration of the net position, despite a very marked increase in gross revenues in recent years.

The situation with TCA and CPAL, who obtain their revenue from serving large major cities permitting high utilization and load factors, is not as critical. However, the granting of transcontinental licence to CPAL might well result in fundamental changes in the status of either TCA or CPAL or both in the next ten to fifteen years.

The speaker urged that the Air Transport Board and/or the Government should now:

(a) Make a very thorough study of the present situation of the carrier industry. In saying this, Mr. Turner acknowledged that the industry was greatly encouraged by the aggressive action being taken in this respect by the Air Transport Board and by the Minister of Transport's statement to the House of

Commons that the Government was aware of the necessity of examining this situation very closely.

(b) Assess present and future traffic potential by regions.

(c) Ascertain the number of regional carriers whom the traffic potential for the various areas could normally be expected to sustain.

(d) Foster the growth of individual regional carriers as had been done in the case of TCA and the US local carriers.

(e) Let it be publicly known that it was the intention of the Air Transport Board and the Government to take steps to ensure that such regional carriers attain a position of security and stability. This was regarded as being essential from the standpoint of aiding such carriers to obtain the very considerable amount of capital required to maintain and re-equip their present fleets.

(f) Generally devise measures to ensure the stability of such carriers by considering:

(i) The re-allocation of DEW line re-supply airlifting.

(ii) Reviewing current post office policy relating to the granting of air mail contracts.

(iii) The diversion of non-miltitary and non-police flying now done by the RCAF and RCMP to commercial carriers.

(iv) Extend the provision of airport and communication facilities to aid smaller carriers.

(v) Carefully review the effect of licencing policy on utilization potential of carriers already in business inasmuch as utilization and load factor are the paramount factors in the success or failure of a charter operation and an excess of operators licenced in any given category could have a very disastrous effect on the utilization attained by existing operators.

(vi) Consider the assignment of feeder lines now operated by TCA and CPAL to smaller carriers. Since in most cases feeder lines currently retained by TCA were clearly unprofitable as separate operations, this would involve a decision as to whether it was in the public interest for these unprofitable feeder lines to be subsidized by the general public treasury or by the revenue passenger on TCA which was the only company in a financial position to subsidize losing feeder lines.

In view of the importance of the carrier industry to the Canadian economy, the speaker urged that there is a crucial need for the immediate development of a definite policy governing the Canadian overall aviation industry. Heretofore, the only discernible policy was when the Government decided to establish a first-class national airline. Mr. Turner had no argument for or against this past decision. However, the quarantining of monopoly rights to TCA on almost all Canadian routes they cared to operate had had a severely limiting effect on the growth potential of all private enterprise companies. It can be argued that if under the new policy transcontinental services were to be divided between TCA and CPAL, there is also a requirement for a policy establishing two other levels of air carrier operations. This basic change in policy presented a golden opportunity to:

(i) Set up a regional air carrier system, i.e. operations of feeder lines, local scheduled passenger services and Group "A" charter aircraft and that such a system might well be compared with the local or domestic airline network now in operation in the USA, and

(ii) Establish policies governing the VFR operators. The helicopter operations are regarded as belonging to an entirely different division of the air carrier industry for this purpose.

Mr. Turner concluded on an optimistic note. The development of the North is essential to the Canadian economy and since the aircraft is the only means of supporting and expanding this development, ways and means will have to be found to permit the smaller air carriers who now have the experience and aircraft to carry out this work to remain financially healthy. In the transitional period until the Northern flying will support these companies, route sharing or subsidizing through mail contracts or both are the only solutions. The general appreciation of the problems by both the Air Transport Board and the Department of Transport is very encouraging, since it indicates a realization that these essential services must be maintained.

G. MILNER

LETTERS TO THE EDITOR

THE BLACK BOX

I TRUST you will not take umbrage if I display my learning.

"A little knowledge" was never a dangerous thing, was it?

"A little learning is a dangerous thing.
Drink deep, or taste not the Pierian spring."

(Pope – Essay on Criticism 11)

Halifax, N.S. T. HOWARD ROGERS

I HAVE read with interest the note on The Black Box on page 205 of the June issue of the Journal.

The "barrier" can be broken down if we realize that electronics is just one part (and a very old one) of both classical and modern physics. The fundamentals of electronics are explained very clearly in "The Rise of the New Physics" by A. D'Abro (Dover Publication). I can see no reason why electronics should be regarded as a mysterious subject.

Ottawa, Ont. W. E. WHITE

C.A.I. LOG

SECRETARY'S LETTER

As we start a new season of the Institute's work, this issue of the Journal reports on the closing events of the old, notably the Annual General Meeting and the Unveiling of the Institute's Monument at Baddeck. Because we were at what Professor Loudon has called the "Mecca of Aeronautical Engineering in Canada", with Mr. McCurdy himself to show us around, history claimed us even more completely than it did in Montreal in February. For this reason I was glad that W/C Pearce, the erstwhile Coordinator of the national celebrations of the Golden Anniversary, was able to be with us; he took some of the photographs for us and, with the compliments of the Standard Motor Company (Canada) Ltd., even offered to provide the Secretary with a car for the occasion – a very generous offer which, as it happened, I was unable to take up.

LETTERS TO THE SECRETARY

I should like to draw attention to my notes on page 303 about new Sections. I really would welcome some letters on this subject, which we can publish in the Journal and so get a representative expression of members' opinions.

And this plea for letters from members is not confined to the question of new Sections. The Journal provides a forum for written discussion on all manner of topics but very few members take advantage of it; in other words very few members take advantage of this privilege of their membership. From my experience as a reader of other publications, I should say that the Letters to the Editor are often the most readable, entertaining and even instructive parts and, in a Journal which is essentially a medium for discussion among members of a society, such correspondence ought to be a very prominent and attractive feature.

Please write!

AMERICAN ROCKET SOCIETY

About eighteen months ago we published a notice about American Rocket Society publications. Such notices should be republished from time to time to bring them to the attention of new members and to refresh the memories of the others. The notice in question was to this effect.

Under an agreement between the A.R.S. and the C.A.I., publications of the one society are made available to members of the other at member rates. *Astronautics*, the A.R.S. monthly magazine, is available to C.A.I. members at $4.50 a year and *ARS/Propulsion*, a journal of research and development, is available at $6.25 a year. These publications may be obtained from the American Rocket Society, 500 Fifth Avenue, New York 36. As a proof of membership, C.A.I. members must quote the numbers of their current year's membership cards, when ordering these publications.

It is worth adding that the A.R.S. has repeatedly expressed its interest in our Propulsion and Astronautics Sections and its willingness to cooperate with these Sections, in advice on speakers and so forth. I would urge the Executive Committees of these Sections to take advantage of this valuable contact.

ASTRONAUTICS ACROSS CANADA

(I seem to be unable to get my mind off the Sections.) The Astronautics Section, at present, is composed almost entirely of members in Toronto, Montreal and Ottawa. There must be a number of members in the western Branches and in Halifax-Dartmouth, Quebec City and other places in the east who are interested and have the necessary qualifications for membership of the Section. I hope they realize that it costs nothing for a C.A.I. member to join a Section and the more extensive the Section membership the better its services will be. All they have to do is apply.

ANGLO-AMERICAN CONFERENCE

The arrangements for the Seventh Anglo-American Conference, in which the C.A.I. will be participating, are now well advanced and, as usual, we have to thank the I.A.S. for having furnished copies of their notice for distribution to our members and for their help in many other ways. I hope that as many C.A.I. members as possible will attend, both in New York and in Toronto, and will extend a warm welcome to the British and American delegates during their visit to Canada.

THE 19th HOLE

The Montreal Branch held its annual golf tournament on the 21st August and no doubt we shall have a full report available for the next issue of the Journal. I was very glad to be able to get down for the closing stages, the buffet supper and the distribution of prizes. This ceremony, under the masterful handling of Mr. Chadborn, gets more entertaining every year; it certainly gives a rousing start to the Montreal Branch activities.

HEADQUARTERS ORGANIZATION

We have reorganized ourselves at Headquarters in an attempt to do more work with fewer people. Mr. W. A. Chisholm, Assistant Secretary, has taken over the Editorship of the Journal and he will also be responsible for all matters of membership. In these duties he will be helped by Miss M. Pearce and Miss M. L. Grant, who has been doing a very creditable job with the membership records for several years. Mrs. G. G. Ross, relieved of the shackles of the Journal, will be able to devote more time to doing all my work for me — as a good "Assistant to" should. There is nothing very hard and fast about these functions; we try to work more like a team than a machine and to distribute our effort to suit the load; so go on writing to "The Secretary" and he will see that you get an answer from somebody.

BRITISH INCOME TAX

The Canadian Aeronautical Institute has been approved for the purposes of Section 16 of the British Finance Act 1958. Members who qualify for relief under that Section will be allowed to deduct the whole of their annual dues from their emoluments assessable to income tax under Schedule E.

The following is an extract from the letter of approval:

"Commencing with the year to 5 April 1959, a member who is assessable to income tax under Schedule E in respect of the emoluments of an office or employment is entitled to a deduction from those emoluments of the whole of the annual subscription which is due and payable by him to the society in the income tax year provided that –

(a) the subscription is defrayed out of the emoluments of the office or employment, and,

(b) the activities of the society so far as they are directed to all or any of the following objects –

(i) the advancement or spreading of knowledge (whether generally or among persons belonging to the same or similar professions or occupying the same or similar positions);

(ii) the maintenance or improvement of standards of conduct and competence among the members of any profession;

(iii) the indemnification or protection of members of any profession against claims in respect of liabilities incurred by them in the exercise of their profession;

are relevant to the office or employment, that is to say, the performance of the duties of the office or employment is directly affected by the knowledge concerned or involves the exercise of the profession concerned."

A member who is entitled to the relief should apply to his tax office as soon as possible for Form P358 on which to make a claim for the relief due to him.

H. C. LUTTMAN, *Secretary*

ANNUAL GENERAL MEETING

THE Annual General Meeting of 1959 was held, from the 15th to the 17th June, at Keltic Lodge, Ingonish, N.S. It is a beautiful place, even when it is raining—which it was—but those who attended will always associate this Meeting with its inaccessability and its demands upon their endurance as motorists. The nearest airport and railway station are at Sydney; thence one must drive about 100 miles to Ingonish, across a ferry and along the Cabot Trail with its stretches of abominable surface. The programme included a visit to Baddeck, which necessitated a round trip of some 120 miles, again over the washboard and pot-holes of the Cabot Trail—and in the rain too. The Institute had arranged for a fleet of hire-cars from Sydney for those who had no transport of their own; an R.C.A.F. party arrived by bus after an adventurous journey; the Secretary's hire-car lost its muffler negotiating the climb over Smokey and thereafter shattered the peace of Cape Breton with frightful cacophony; altogether the motoring associated with this Meeting was one of its more memorable features.

Most of the members arrived at Keltic Lodge on Sunday, the 14th June, and the following day they drove to Baddeck for the unveiling of a Monument and a short visit to the Alexander Graham Bell Museum. That same evening, on their return to the Lodge, the Business Session of the Annual General Meeting took place. The Test Pilots Section held its Annual General Meeting in the morning of the 16th June but the Annual General Meetings of the Propulsion and Astronautics Sections, scheduled for the same time, had to be abandoned for lack of numbers. The Honours and Awards Session, at which the W. Rupert Turnbull Lecture was delivered, was held in the afternoon of the 16th June, followed by the Reception and Annual Dinner in the evening. Technical sessions took place in the mornings of the second and third days; the Meeting was adjourned at noon on the 17th June.

Total registration was 75, and 102 members and guests attended the Dinner —a very satisfactory attendance in the circumstances.

The retiring President, Dr. G. N. Patterson, transfers the Chain of Office to the new President, Dr. D. C. MacPhail

MONUMENT AND MUSEUM

The main reason for holding this Meeting in Cape Breton was the unveiling of a Monument in recognition of the 50th anniversary of powered flight in Canada. The Monument had been erected by the Institute in the grounds of the Alexander Graham Bell Museum at Baddeck, overlooking the scene of the first flight.

The ceremony is described on pages 284 to 287. It took place at 2.30 pm on the 15th June and the time table allowed for members to visit the Museum while they were there. Many of them had not previously visited this fascinating but remote shrine of Canadian aviation and this visit to the Museum, with its remarkable collection of Dr. Bell's experimental equipment, was a most interesting and unusual feature of the Meeting programme. More time could have been set aside for it with advantage.

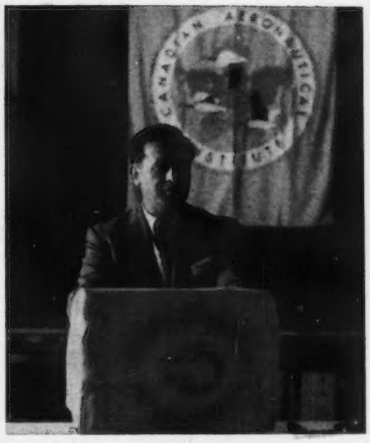
BUSINESS SESSIONS

Of the Institute

The Institute's Annual General Meeting was opened by Mr. R. Wallworth, Chairman of the Halifax - Dartmouth Branch, with a short speech of welcome to Nova Scotia. This was followed by the presentation of the Reports of the various Committees; Finance, by its Chairman, Mr. A. E. Ades; Admissions, by CDR N. A. Smith, a member of the Committee; Programmes, by Mr. J. L. Orr, its Chairman; Publications, by the Secretary, in the absence of any members of the Committee; Planning, by the Secretary; and 50th Anniversary, by CDR E. B. Morris, Chairman of the Committee. Thereafter the President gave a résumé of the Annual Report of the Council. There was some discussion of each Report as it was presented and each was duly adopted. They are reproduced in full on pages 291 to 300 of this issue.

Of the Test Pilots Section

Mr. E. L. Bunnell, the retiring Chairman of the Section, presided over the Annual General Meeting of the Test Pilots Section which was held in a Sunporch of one of the Cottages. The presentation of the Annual Report was deferred, because of the absence of the Secretary/Treasurer, but a good deal of business was considered. Such items as the proposed Scholarship for test pilots, the Instrument Rating of civil test pilots, Branch Spokesmen, and the part played by the Section in the Institute Meetings held during the year were reviewed. The meeting then discussed the development of relations with the Society of Experimental Test Pilots (of the U.S.A.) and ways and means of increasing membership. Finally the meeting adopted an important resolution, moved by W/C P. A. Hartman and seconded by Mr. H. F. Everard; it was announced by the President at the Annual Dinner and will be referred to later in this report.



Mr. R. Wallworth, Chairman of the Halifax-Dartmouth Branch, opening the meeting

Of the Propulsion and Astronautics Sections

As stated above, the attendance of the members of the Propulsion and Astronautics Sections was insufficient to enable the Annual General Meetings of these Sections to take place. However about half a dozen members of each were present, including Mr. F. H. Keast, the incoming Chairman of the Propulsion Section, and Dr. H. S. Ribner and Dr. H. J. Luckert, the retiring Chairman and incoming Vice-Chairman, respectively, of the Astronautics Section; the Secretary called both groups together for an informal discussion of a suggestion that he wished to put before them.

His suggestion was that the two Sections should merge into one. He pointed out that, in the pre-Sputnik days, the Propulsion Section had been formed to satisfy to some extent the needs served by the American Rocket Society in the States and to promote the Institute's relations with that Society. After the launching of the first Sputnik, when the interest in astronautics had increased sharply, it was natural that an Astronautics Section should have been set up, but the Secretary wondered whether the two Sections were not overlapping in many respects. He suggested that it might be easier and, in the long run, to their mutual benefit, if the Sections were to combine rather than attempt to define their respective fields of interest.

There was some discussion of the proposal and Mr. Keast, Dr. Ribner and Dr. Luckert agreed to refer it to their Executive Committees and the memberships of the Sections.

HONOURS AND AWARDS

The Honours and Awards Session was well attended by members and guests, including several of the ladies attending the Meeting with their husbands. The proceedings are reported fully on pages 288 to 290 and it is sufficient here to list the award winners as follows:

Honorary Fellow
Mr. R. B. C. Noorduyn (posthumously)

McCurdy Award
Professor T. R. Loudon

F. W. (Casey) Baldwin Award
Mr. H. R. Warren, Mr. B. Cheers and Mr. R. J. Templin

W. Rupert Turnbull Lecture
Mr. D. N. Kendall

DINNER

Before the Dinner, a Reception was held in the Main Lounge of the Lodge, sponsored most generously by fifteen Sustaining Member companies, whose names were listed on the Dinner Menu cards.

The Head Table at the Dinner included those members of the 1959/60 Council who were able to attend the Meeting, the winners of awards, and Mr. McCurdy. In introducing them, the President referred to Mr. and Mrs. Robert Baldwin, who were also present, and welcomed them to the Dinner. After this introduction the President read a telegram which he had sent to the Institute's Patron, the Prince Philip, as follows:—

"As Your Royal Highness is aware the year 1959 is the 50th Anniversary of Flight in Canada. The exact date was the 23rd February and the message of good wishes which you graciously sent to me when the Canadian Aeronautical Institute held its Special meeting on that date was deeply appreciated.

"In further celebration of this anniversary the Institute has erected a monument at Baddeck, Nova Scotia, overlooking the Bras d'Or Lakes from which the first flight was made. It will be unveiled by His Honour the Lieutenant-Governor of the Province of Nova Scotia on the 15th June. On the next two days the Institute will hold its Annual General Meeting at nearby Ingonish. In bringing these events to your attention, Sir, I wish to convey the greetings of the Council and members of the Institute and to express our pleasure at the interest which, as our Patron, Your Royal Highness has always displayed in our activities.

"The Institute is participating in the luncheon being arranged for Your Royal Highness by the Engineers and Scientists of Canada, in Toronto on the 29th June. We are looking forward to this occasion."

G. N. Patterson, President

His Royal Highness had replied:—

"I hope all the arrangements for the 15th June and for the Annual General Meeting at Ingonish will be most successful. The 50th Anniversary of Powered Flight in Canada is a most important occasion and I am very pleased that the Canadian Aeronautical Institute is taking so much trouble to celebrate the event in such a suitable way. I am looking forward to seeing some of your members on June 29th."

Philip Patron

There was warm applause when the President read these messages.

The President then announced that, at their Meeting that morning, the Test Pilots Section had elected Air Commodore the Honourable J. A. D. McCurdy as Permanent Honorary Chairman of the Section. He called upon him to say a few words.

Mr. McCurdy spoke with great emotion. He congratulated the Institute on the erection of the Monument at Baddeck—a tribute by the best brains in the techniques of aircraft design and manufacture to Dr. Alexander Graham Bell's efforts to produce a machine capable of flying. He recalled how he, Mr. Baldwin and Professor Loudon had admired Dr. Bell; in those days they were young men in their 20's and they were tremendously inspired by Dr. Bell's genius and leadership.

He paid a moving tribute to Mr. Baldwin whom he described as an intellectual genius, a very great friend and close associate; their association was based on a deep love and understanding. Stressing the point that all the members of the Aerial Experiment Association contributed to all their four aircraft, he begged that arguments about who did what should be forgotten. The Association, working together,

Part of the Head Table at the Dinner: (l to r) Dr. G. N. Patterson (President), The Hon. J. A. D. McCurdy, Dr. D. C. MacPhail, Mr. R. Wallworth

contributed the successful development of the aileron and the tricycle undercarriage with steerable nose-wheel and, as Dr. Turnbull had contributed the controllable pitch propeller, so their contribution had been to world aviation and not only to Canada.

In a reference to Professor Loudon he urged the Institute to remember the great debt owed to him by aeronautical science, as the creator of a Chair of Aeronautical Engineering and the teacher of scores of Canadian engineers.

Finally he expressed his respects to the R.C.A.F. and to all those who had supported him during the anniversary year.

He received a standing ovation. The President remarked:

"The most wonderful thing about this Golden Anniversary is that we have Mr. McCurdy here to help us celebrate it."

In introducing the Principal Speaker, the President said that since Professor Loudon had already been introduced to the Meeting, as the winner of the McCurdy Award, he would content himself with some personal reminiscences from his association with him at the University of Toronto; both as a student and later as a colleague he had known Professor Loudon for a good many years. In this spirit of reminiscence, Professor Loudon opened his address with a story about a battle between the arts and engineering students of his day, in which Mr. McCurdy had used a fire hose with impressive results and, in Professor Loudon's opinion, had thereby been one of the first to apply jet propulsion effectively.

Professor Loudon's address, entitled "The Development of Canadian Aeronautical Engineering", is reproduced on pages 253 to 260 and need not be summarized here. At its conclusion CDR Morris moved a vote of thanks.

In closing his term as President of the Institute, Dr. Patterson thanked the Chairmen of all the Committees who had worked with him, and Mrs. Ross and the Secretary; he said that he had enjoyed the association with Mr. Boyd, a member of the retiring Executive Committee and the new Vice-President. He referred to his successor, Dr. MacPhail, as one of Canada's leading scientists and, asking him to come forward, he transferred the President's Chain of Office to him.

Before adjourning the Dinner, Dr. MacPhail thanked the retiring Council for the work they had done and the state in which they were handing on their responsibilities. He said that the incoming Council had already held a very satisfactory meeting which bore promise of an active and vigorous administration in the coming year.

Hydrodynamics Session: (l to r) Mr. G. Ashe, Mr. M. S. Kuhring (Chairman) and Mr. M. C. Eames

TECHNICAL SESSIONS

The two technical sessions of the Meeting dealt with Hydrodynamics and Flying—Past, Present and Future.

Morning Session, June 16th
HYDRODYNAMICS

Reported by J. W. Milman

The session was held in the Convention Hall and was attended by approximately 60 members. Mr. M. S. Kuhring of NRC was in the chair. Two papers were read, the first "The Influence of Cavitation on Hydrofoil Craft Design" by M. C. Eames of NRE and the second, "Ditching Tests on a Model of a Large Reconnaissance Aircraft" by E. S. Turner of NRC read by G. Ashe of NRC. No attempt will be made to describe the papers, since they may be published at a later date; however the discussion which followed their presentation is summarized below.

Discussion on Mr. Eames' paper

S/L M. R. Barrett, RCAF, asked whether the supercavitating propeller tested on the R-100 was the first such propeller to be used. Mr. Eames replied that earlier propellers had been designed on a trial and error basis, for record breaking speed boats and the like. These usually employed straight wedge sections. The significance of the R-100 propeller is that it was the first to be designed on the Tulin theory which leads to low drag and high efficiency.

Dr. D. C. MacPhail, NRC, asked whether the surface layer of seawater affected the onset of cavitation by virtue of its high air content. Mr. Eames replied that this was certainly so. Approximately, the effect is equivalent to a reduction of the static pressure of the order of 5 ft head of water.

G/C R. McMillan, RCAF, asked whether the porpoising tendency of a cavitating area stabilized craft could be used to cancel out the pitching motion in rough water.

Mr. Eames replied that the effects would be out of phase and he did not think such a scheme would work.

Dr. G. N. Patterson, UTIA, asked about the effects of the surface of the foil on the boundary layer and the onset for cavitation.

Mr. Eames said there were many such effects, and that he had presented an over-simplified picture of cavitation inception. Generally speaking, any practical foil surface usually results in early establishment of turbulent flow. Laminar separation, for example, is seldom a problem. The most significant point is, perhaps, the effect of a small cavitation bubble on the flow behind it. It is possible for example, for a relatively small area of cavitation at the leading edge to cause separation over the entire chord. The interrelations between cavitation, separation and ventilation require considerable further study.

Mr. J. L. Orr, DRB, asked whether boundary layer control techniques had been considered for hydrofoil craft. Mr. Eames replied that a certain amount of theoretical work had been done, but he had not heard of boundary layer control being employed in practice. The power requirements were probably prohibitive, and structural problems would be involved because of the very small thickness ratios involved.

In reply to a second point Mr. Eames agreed that the possibilities of boundary layer control had not been ruled out and that further study was desirable.

Dr. H. S. Ribner, UTIA, asked whether controlled variation of dihedral might not enable the area stabilized system to develop stability characteristics as good as the incidence controlled craft.

Mr. Eames replied that he had not meant to imply that the incidence controlled craft was superior from the stability point of view. It was certainly more efficient, from a drag point of view, but excellent stability characteristics would be obtained with fixed incidence. He therefore felt that control of dihedral on an area stabilized boat, which would be a refinement and a complication, would probably not be justified. One of the attractive features of area stabilized boats, for example, is their lack of moving parts.

F/L L. S. Lumsdaine, RCAF, asked why a catamaran type of hull was not satisfactory at low speed, and queried the effect of impacting floating debris.

Mr. Eames replied that the type of catamaran dictated by the desire for a forward centre of gravity had very greatly increased resistance when operating at displacement speeds in rough water. It therefore reduced the cruising range and endurance in this mode of operation. With regard to safety, a 5-ton craft had suffered no damage impacting a railroad tie at about 40 knots, and he did not feel this was a serious difficulty.

Discussion on Mr. Turner's paper

F/L L. S. Lumsdaine, RCAF, asked if tests were done with elevator horns in place.

Mr. Ashe replied that they were not.

S/L H. E. Holland, RCAF, asked whether the tests were made with the model simulating full or empty fuel tanks.

Mr. Ashe replied that empty tanks were assumed.

Mr. M. S. Kuhring, NRC (Chairman), asked about the effect of compression loads against tension loads on the fuselage.

Mr. Ashe replied that one of the interesting features of the tests was the measurement of bending forces in the fuselage. It was expected that tension would be developed in the lower part of the fuselage due to the drag developed by the aft end. The model was equipped with a hinge at the top of the fuselage and links of known strength at the bottom. It was found, after a few tests, that the links remained unbroken but the hinges were torn apart. The hinge was therefore placed at the bottom of the fuselage and the tension measuring device moved to the top.

Abbass

Flying Session: (l to r) W/C P. A. Hartman, S/L R. G. Christie, Mr. E. L. Bunnell (Chairman) and Mr. C. T. Travers

Surprisingly high tension forces were developed. The model which weighed about 23 lb, flew at about 40 ft/sec and developed tensions of the order of 50 lb. It appears that the hydrodynamic forces developed toward the rear of the fuselage tend to hold the tail down while the fore part tends to fall more quickly. The wings apparently contribute little lift under the condition.

Mr. M. C. Eames, NRE, asked whether the largest pressure was 20 psi.

Mr. Ashe replied that he thought it was, speaking from memory.

Morning Session, June 17th
FLYING — PAST, PRESENT AND FUTURE

Test pilots are a resourceful lot. This session, which was organized by the Test Pilots Section, was remarkable in that only one of the three speakers listed on the programme was there to deliver his paper in person and even the Chairman listed was not present. Mr. E. L. Bunnell took the chair in the place of S/L O. B. Philp and fulfilled these duties with his usual competence; Mr. C. T. Travers delivered the paper prepared by Mr. J. R. K. Main, entitled "The Record of the Past"; S/L R. G. Christie spoke in place of F/L J. H. Waldie; and W/C P. A. Hartman read his own paper on the "Next Fifty Years". In the atmosphere and surroundings of Cape Breton in the Golden Anniversary year these papers formed a most appropriate group and it was also appropriate that Mr. McCurdy, who started it all, should have been in the audience.

Mr. Travers reviewed the development in safety, punctuality, range, speed and size of aircraft in the last thirty-five years and emphasized the importance of the growth of facilities and organization, in transforming the achievements of Kittyhawk and Baddeck to a recognized means of public transport. In describing the present state of the art, S/L Christie divided the field into civil, industrial and military and concluded that the aeroplane is making an increasing contribution to the development and economy of the country; he expressed his confidence that the foresight and tenacity which has developed Canadian flying in the last fifty years would meet the challenge of the future. W/C Hartman made a case for the development of a large transport with VTOL capability and he considered that a radical departure from past design concepts would be needed to exploit to the full the potentialities of air transport in the coming years.

There was no discussion of these papers but at their conclusion Mr. D. H. Rogers, in moving a vote of thanks to the three speakers, referred to each paper in turn and commented upon it.

Since this was the closing session of the Annual General Meeting Mr. Bunnell relinquished the Chair to Dr. D. C. MacPhail, the new President, who, in adjourning the Meeting thanked all those who had taken part in it and looked forward to a successful and satisfying season in the coming year.

THE SILVER DART MONUMENT

THE Monument which the Institute had erected in the grounds of the Alexander Graham Bell Museum, at Baddeck, N.S., to mark the fiftieth anniversary of powered flight in Canada, was unveiled by Major General the Honourable E. C. Plow, Lieutenant-Governor of the Province of Nova Scotia, on the 15th June, 1959.

The ceremony was a part of the programme of the Annual General Meeting, which is reported upon elsewhere in this issue, and about 100 members and guests attended. Unfortunately the weather, which had been excellent for a few days before the event, turned into low clouds and a series of torrential showers. Several of the guests who had planned to come by air were unable to do so and the fly-past of R.C.N. and R.C.A.F. aircraft had to be cancelled.

Before the ceremony the Lieutenant Governor and Mrs. Plow joined the members and guests at a buffet luncheon arranged by the Ladies Auxiliary of the Victoria County Memorial Hospital in the Legion Hall.

Because of the weather, the main part of the ceremony was held in the Museum; from which the Monument, standing about a hundred paces away, could be clearly seen. There the President and the Lieutenant-Governor delivered their addresses from the top of a flight of steps.

The President said:

"The Canadian Aeronautical Institute has chosen the occasion of its Annual General Meeting in this Fiftieth Anniversary year of the first powered flight in Canada to set up a permanent memorial to mark our respect for the contributions of the Aerial Experiment Association. This Association under the leadership of Dr. Alexander Graham Bell produced a series of aircraft, including the Silver Dart, which was the first powered aircraft to fly in Canada. This aircraft was engineered largely by John McCurdy and flown by him over the ice of Baddeck Bay, Bras d'Or Lakes, here in Cape Breton Island on February 23rd, 1909. An earlier aircraft called the Red Wing, developed by this organization, was flown over a lake in New York State by "Casey" Baldwin on March 12, 1908, who by this feat became the first Canadian to fly in a powered aircraft. We commemorate the remarkable engineering accomplishments of the pioneering members of the Aerial Experiment Association by a monument surmounted by a model expressive of the Silver Dart, symbolic of these achievements.

"We wish to express our sincere thanks to the Department of Northern

Mrs. G. G. Ross, C.A.I., and Mr. J. K. Hawkshaw, Field Aviation, inspecting the Monument before the ceremony

N.S. Film Bureau

Abbass

His Honour, the Lieutenant-Governor, delivering his address to those gathered in the Alexander Graham Bell Museum before the unveiling

Abbass

His Honour, Major-General E. C. Plow, Lieutenant-Governor of Nova Scotia, unveiling the monument with Dr. G. N. Patterson, President C.A.I.

Affairs and National Resources for granting us permission to erect this monument in such an appropriate place—on the grounds of the Alexander Graham Bell Museum. Our thanks are due also to the designer of the monument, Dr. Muller, and to Field Aviation, Chappells Ltd. and Mr. McPhee, who were responsible for the construction of the surmounting figure and column, respectively.

"While the specific event of interest today is the first flight of a powered aircraft in Canada, we must also pay tribute to those succeeding events which have led to the establishment of aeronautical education, research and industry in Canada since that epic day in 1909. A detailed list of the significant dates in Canada's aeronautical history would be too long for presentation here. Perhaps you will agree that the following "firsts" were particularly significant:

(a) 1910—Production of the first aircraft engine in Canada by W. W. Gibson (engine is now in the Aeronautical Museum, Ottawa).

(b) 1915—Establishment of the Curtiss Aviation School which became the first mass production aircraft factory in Canada producing Curtiss JN training airplanes.

(c) 1918—Establishment of the first Aeronautical Research Laboratory at the University of Toronto by J. H. Parkin.

(d) 1919—Organization of the Royal Canadian Air Force.

(e) 1929—Organization of government sponsored aeronautical research in the National Research Council.

(f) 1935—Setting up of the first permanent course in aeronautics (at the University of Toronto) by Professor T. R. Loudon.

(g) 1946—Introduction of naval aviation into the Royal Canadian Navy. In more recent times, many other significant events have occurred in Canadian aeronautics, including the organization of the Canadian Aeronautical Institute in 1954.

"It was significant that the Aerial Experiment Association was composed of both Americans and Canadians. All four of the powered aircraft built by the Association, including the Silver Dart, were constructed in the machine-shop operated by Glenn Curtiss in Hammondsport, N.Y. We look forward to a bright future in aeronautics in Canada but we will not be surprised if our American neighbours play a part in it. Plans for launching a Canadian-instrumented satellite from Vandenburg Air Force Base are under way. A Commonwealth Space Committee is under consideration. In the future we look forward to another "first"—when the first satellite will be launched from Canadian soil.

"Your Honour, Ladies and Gentlemen, we are pleased to have with us today the following distinguished guests.

Mr. E. A. Manson, Minister of Trade and Industry, and Mrs. Manson
Mrs. F. W. Baldwin and
Mr. and Mrs. Robert Baldwin
Air Commodore The Honourable J. A. D. McCurdy
Mr. Donald MacLeod, Chairman, Baddeck Committee, and Mrs. MacLeod
Mr. E. C. Hibbert, President, Fairey Aviation Company of Canada, and Mrs. Hibbert
Mr. R. W. Archibald, representing the Engineering Service of the Department of Northern Affairs, and Mrs. Archibald.

"And now it is my privilege to ask His Honour, Major-General The Honourable E. C. Plow, Lieutenant-Governor of the Province of Nova Scotia to unveil the monument."

The Lieutenant-Governor thanked the President and said:

"Today we are witnessing a most impressive ceremony and I would like to congratulate the Canadian Aeronautical Institute for the patriotism and imagination they have displayed in erecting this memorial.

"Canada, probably more than any other country, has profited by the

Abbass

Those who braved the rain take a closer look at the Monument after its unveiling

tremendous advance that has been made in aviation. Without the use of aircraft to move people and material from one place to another in this vast country, we would never have developed as rapidly as we have done over the past half century.

"Every one of us should be most appreciative of the great contribution that some of our distinguished Canadians have made to aviation, one of whom, who will be remembered for all time, is the Hon. J. A. D. McCurdy.

"Too often in the past Canadians have underestimated or ignored the calibre and achievements of their fellow countrymen. If we are to become one of the very great and highly respected nations of the Western World, we must learn to honour and encourage those of our citizens who display outstanding qualities.

"It is most fitting that this memorial should be erected close to the Alexander Graham Bell Museum, which holds so many practical examples of the inventive genius of this man in the field of aviation. It will also be an indication to future generations what an inspiration this great man was to the young men of his day.

Head-on view, showing both plaques

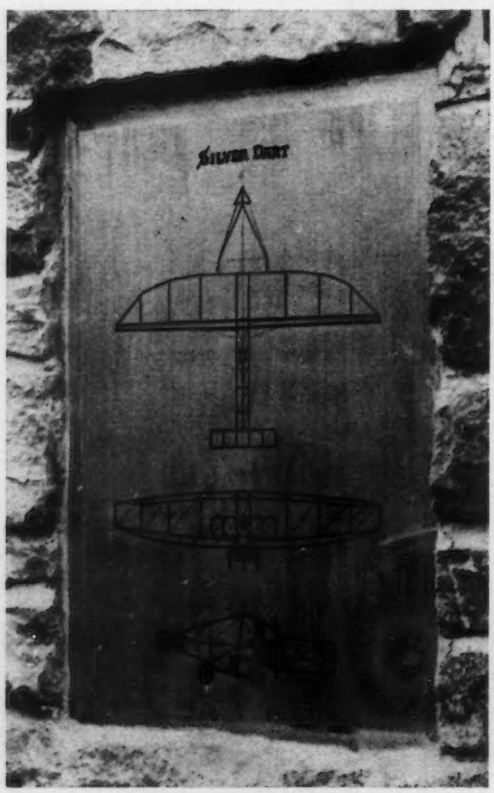
"To a great extent the future of aviation in Canada is in the hands of the members of the Canadian Aeronautical Institute. In its present form this is a young organization, but it has clearly shown that it is strong and progressive. We can all rest assured that under their guidance the Canadian contribution in the field of aviation will be as great in the future as it has been in the past."

Followed by a number of hardy souls, including the Honourable J. A. D. McCurdy himself, the Lieutenant Governor and the President then braved the weather and the sodden grass, and went outside to the site of the Monument. With the words

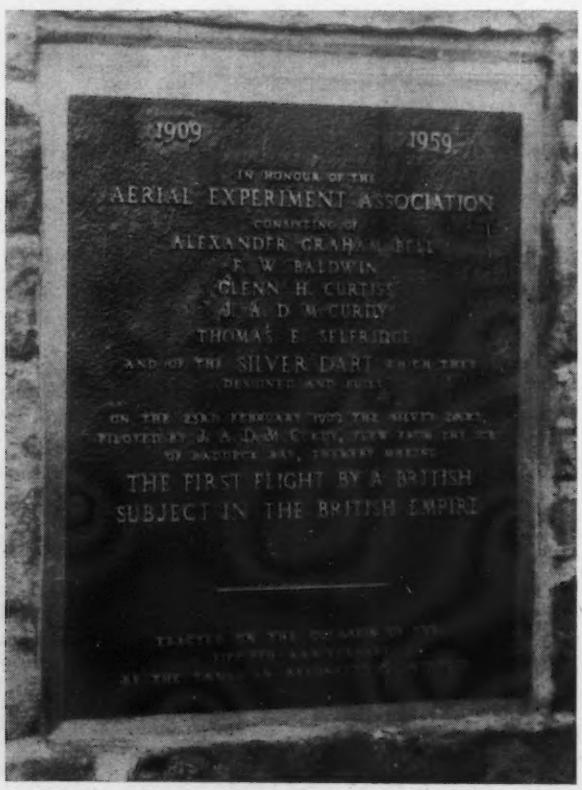
"I now unveil this monument to the Aerial Experiment Association and the Silver Dart"

His Honour released the Union Flag which covered the plaques and the ceremony was complete.

In spite of the weather everybody enjoyed themselves due, in no small measure, to the enthusiasm and cheerfulness displayed by the Lieutenant-Governor. The Institute was honoured by his consenting to unveil the Monument and is indebted to him for the spirit in which he did it.



Starboard plaque



Port plaque

ACKNOWLEDGEMENT

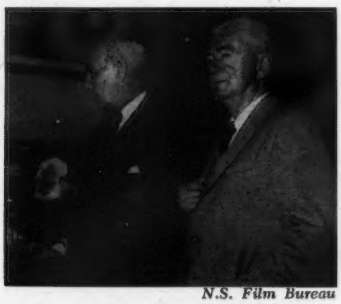
The Monument was designed by Dr. Leonard Muller of the University of Miami, whose wife, Mrs. Barbara Fairchild Muller, is a granddaughter of Dr. Alexander Graham Bell. Some refinements were introduced by Dr. Muller after a small scale mock-up had been built by some of the staff of the National Research Council. The figure or crest of the column was made in stainless steel by the Field Aviation Company Ltd. of Oshawa. The Department of Northern Affairs and National Resources, the agency responsible for museums and national parks, did the detail design of the foundation and this work was carried out by Chappells Ltd. of Sydney, the firm which built the Museum. The stonework was executed by Mr. Alphonse McPhee of Louisdale, Cape Breton. As a protection against the elements the stonework is capped by a stainless steel plate, made by Rolls-Royce of Canada Ltd.

There are two bronze plaques, one of them bearing the inscription and the other a three-view GA drawing of the Silver Dart. The drawing from which the latter was etched was prepared by Spartan Air Services Ltd. of Ottawa and both plaques were made by Ottawa Rubber Stamp and Engraving Ltd.

The assembly of these many contributions was organized by CDR E. B. Morris of H.M.C.S. Shearwater, working from Dartmouth, N.S., and the Secretary of the Institute, working from Ottawa, with a great deal of help from Mr. R. W. Archibald, the Resident Engineer of the Department of Northern Affairs and National Resources, stationed at Baddeck. Perhaps some day they will record the details of this extraordinary undertaking.

Abbass

TCA representatives: Mr. M. K. McNaughton, Mr. W. J. Lawlor, Mr. R. D. Williamson and Mr. A. E. Ades



N.S. Film Bureau

Genius loci: The Hon. J. A. D. McCurdy and Prof. T. R. Loudon beside a portrait of Dr. Alexander Graham Bell

Abbass

Mr. J. G. Portlock (Edmonton), Mr. W. E. Jamison (Calgary), Mr. R. J. McWilliams (Vancouver), and Mr. H. C. Luttman (Secretary)

Abbass

Halifax-Dartmouth: CDR E. B. Morris, Mr. E. C. Garrard, Mr. R. Wallworth, LCDR W. H. Frayn and Mr. J. W. Milman

N.S. Film Bureau

The Hon. J. A. D. McCurdy, the Hon. Major-Gen E. C. Plow, Lieutenant-Governor, W/C P. A. Hartman and the Hon. E. A. Manson, Minister of Trade and Industry

Abbass

Mr. D. Boyd, Dr. D. C. MacPhail, Prof. T. R. Loudon and Dr. G. N. Patterson

HONOURS AND AWARDS

THE presentation of the Institute's honours and awards took place on the 16th June, at a special session of the Annual General Meeting held at Keltic Lodge, Ingonish, N.S. The session included the delivery of the W. Rupert Turnbull Lecture for 1959.

The President, Dr. G. N. Patterson, was in the Chair.

HONORARY FELLOW

The President explained that the highest honour that the Institute could bestow was that of Honorary Fellowship and that this year, a few days before his death, the Council had decided to confer this honour on Mr. R. B. C. Noorduyn. In the circumstances it had been hoped that a member of Mr. Noorduyn's family would be able to accept the Certificate but this had proved impossible; instead Mr. I. J. Hammill, Executive Vice-President of Walter Kidde and Company of Canada and an old friend of the family, would accept it on their behalf. He asked the Secretary to read the citation, which was as follows:

Mr. R. B. C. Noorduyn

"Mr. R. B. C. Noorduyn came to Canada in 1934 but aircraft of his design, or with which he had been closely associated, had been used extensively in Canada for many years before that. Canadian aviation, and particularly that branch of it which has contributed so enormously to the development of national resources, is for ever indebted to him.

"He was born in Holland and educated in the Engineering College at Bingen, Germany. Thence he moved to England in 1913 and served first with Sopwith and later with other British aircraft companies in the design and production of military aircraft. After the war, in 1920, he went to the U.S.A. as assistant to Anthony Fokker and remained as representative of the Fokker Company. He held a number of executive positions in the Fokker Aircraft Corporation from 1924 to 1928, until he joined Bellanca in 1929. In 1932 he transferred to Pitcairn Aircraft Inc. While with these companies he was responsible, notably, for the Fokker Universal and the Bellanca Pacemaker, names honoured in the history of Canadian flying.

Mr. I. M. Hammill accepting the scroll of Honorary Fellowship on behalf of Mr. R. B. C. Noorduyn

"In 1934 he came to Montreal to design the Norseman and founded Noorduyn Aviation Ltd. in 1935. This Company produced about 1,000 Norsemen and some 3,000 Harvards before closing at the end of the war. The Norseman license was sold to the Canadian Car and Foundry Co., but Mr. Noorduyn bought it back in 1953 and formed a new Company, Noorduyn Norseman Aircraft Ltd., which still provides service to Norseman users throughout the world.

"When the Norseman was born in 1934, the newly-formed company of Noorduyn Aircraft was located on the top floor of the Canada Cement Building in Montreal. There Mr. Noorduyn built a wooden mock-up, from the engine mount back to the rear cabin bulkhead, and many famous bush pilots on visits to Montreal were corralled and put in this mock-up, to criticise and suggest. The result was an aircraft built for the country rather than converted from types available elsewhere. Mr. Noorduyn possessed a profound understanding of the Canadian air transport problem and he was ever eager to talk about it.

"His office door was always open and those who worked with him knew him as a man, approachable and ready to listen to their troubles. He could be found poring over some engineering problem at the drafting board or sitting on a trestle in the shop talking it over with men doing the job. Certainly there were many occasions when he would "blow off steam", but not without justification and usually on relatively trivial pretexts; he could be relied upon to meet major difficulties with a cool head and calm judgement. He never forgot to express his appreciation of a job well done.

"Mr. Noorduyn died in Burlington, Vermont, on the 22nd February. His memory is held in loyalty and affection by many Canadians who knew and worked with him and his contribution to Canadian aeronautical engineering, still expressed by the many Norsemen in service today, is honoured by the Institute."

In accepting the Certificate from the President, Mr. Hammill said that Mr. R. H. Noorduyn, Mr. Noorduyn's son, was very sorry that he could not accept the Certificate in person; for the family was most appreciative of the Institute's action.

THE McCURDY AWARD — 1958

The McCurdy Award for achievement in the aeronautical technical field is regarded as the premier award of the Institute. Each year the winner is very carefully selected, by a special Committee, from nominations submitted by individuals and organizations across Canada. The Award, consisting of a Trophy and a Silver Medal, was introduced in 1954 by the Institute of Aircraft Technicians, one of the groups which amalgamated to form the Canadian Aeronautical Institute.

The President announced that Professor T. R. Loudon had been selected as the winner of the McCurdy Award

Abbass

The Hon. J. A. D. McCurdy (l) presenting the McCurdy Award to Prof. T. R. Loudon

for 1958 and he called upon the Secretary to read the citation. This was as follows:

Professor T. R. Loudon

"There are few branches of aeronautical science in Canada which have not been profoundly influenced by Professor T. R. Loudon. He has been first and foremost a teacher, and a very large proportion of the engineers and scientists in the field today received from him their professional training and inspiration.

"As long ago as 1907 he joined the staff of the University of Toronto as a lecturer and was appointed Professor of Applied Mechanics in 1914. He originated the Aeronautical option of the Engineering Department; he was the Head of this Department, as well as of the Civil Engineering Department, until his retirement from the University in 1954. His interest in teaching did not end with active work at the University and since 1954, as Personal Assistant to the Chief Engineer at the De Havilland Aircraft of Canada, he has promoted company training schemes and, it may be added, he has been a tower of strength in the Institute's activities in the field of education and training.

"In addition to his teaching, Professor Loudon has found time for a good deal of consulting work on both civil and aeronautical projects. He has written a text book on "Applied Statistics", a training manual on "Theory of Flight" and numerous technical papers.

"During the 1914-18 war he served in the Canadian Army and in 1939 he joined the R.C.A.F., in which he organized the Aeronautical Engineering School in 1940, gave a course of Aerial Navigation for aircrew and served as Chief Technical Officer and Commanding Officer of the Test and Development Establishment.

"If any further evidence of Professor Loudon's spirit is needed, it might be mentioned that he obtained a private pilot's licence at the age of 54. His University classmates, F. W. (Casey) Baldwin and J. A. D. McCurdy, took to the air at an earlier age, but Professor Loudon was not a man to let them get away with it.

"A teacher makes a very special contribution to his profession. Professor Loudon's many years of teaching have given to Canadian aviation one of its most valuable assets — its professional scientists and engineers. It is for this achievement in the aeronautical technical field that the Institute now presents its premier Award, the McCurdy Trophy."

The President then asked Air Commodore the Honourable J. A. D. McCurdy to present the Award, which bears his name. Before doing so, however, Air Commodore McCurdy asked permission to say a few words and he took the opportunity to extend a very warm welcome to the members and to the Institute holding its Annual General Meeting in Cape Breton. He then turned to the subject of Professor Loudon and recalled the days when they were students together at the University of Toronto, listening to "those horrible professors"; he could never understand them but Professor Loudon had appeared to and, in any event, he was sure that Professor Loudon had learned from that experience to be sympathetic to the student's problems. Air Commodore McCurdy evidently enjoyed presenting the Award to Professor Loudon and there was a good deal of light banter, which the audience enjoyed as well. It was a very happy occasion.

Professor Loudon expressed his very sincere appreciation of the Award and said how glad he was to visit this part of the country, which he had never visited before in spite of repeated invitations.

Abbass

Mr. H. R. Warren and Mr. B. Cheers, Baldwin Award

F. W. (Casey) BALDWIN AWARD

The F. W. (Casey) Baldwin Award was introduced in 1957 and is presented annually to the author of the best paper, in terms of originality of material and writing skill in presentation, published in the Canadian Aeronautical Journal during the preceding calendar year. (The W. Rupert Turnbull Lecture, though invariably published in the Journal, is excluded from this competition.) The Award consists of a Silver Medal.

Mr. H. R. Warren, Mr. B. Cheers, and Mr. R. J. Templin

The president announced that this year the winning paper had three authors, Mr. H. R. Warren, Mr. B. Cheers, and Mr. R. J. Templin, whose paper entitled "Aeroballistic Range Measurements of the Performance and Stability of Supersonic Aircraft" had been published in the December 1958 issue. Mr. Warren and Mr. Cheers were present at the Meeting and each received a Medal from the President. The Secretary was asked to send Mr. Templin's Medal to him.

In acknowledging his Award Mr. Warren referred back to the McCurdy Award winner and paid tribute to Professor Loudon, whose student he had been. He recalled particularly one piece of advice—"not to argue with the Chief Engineer"! In connection with the paper in which he was a co-author, he made the point that it was perhaps a peculiarly Canadian achievement for three authors, Mr. Cheers at C.A.R.D.E. at Valcartier, Mr. Templin at N.R.C. at Ottawa and himself at De Havilland, Toronto, to collaborate in this way and he credited the Aerial Experiment Association with establishing this tradition of co-operation between widely separated groups.

Mr. Cheers generously claimed that Mr. Warren deserved the principal credit for the paper.

W. RUPERT TURNBULL LECTURE

The W. Rupert Turnbull Lecture was established in 1955 to commemorate the pioneering work in aeronautical engineering carried out by Dr. Turnbull of Rothesay, N.B. Some of this work predated the flight by the Wright Brothers. Each year the Council invites an eminent scientist or engineer to deliver the Lecture and it has been customary to invite Canadians and non-Canadians in alternate years. The Lecturer receives a Certificate and an honorarium.

Mr. D. N. Kendall

The President introduced Mr. D. N. Kendall, President of the Photographic Survey Corporation and its associated companies, as the fifth W. Rupert Turnbull Lecturer. Mr. Kendall's Lecture, entitled "Air Survey — The Key to National Resources", will be published later in the Journal, but Mr. E. C. Garrard of the Fairey Aviation Company of Canada has prepared the following summary of this part of the Session:

"Prior to starting the formal Lecture Mr. Kendall paid tribute to the early efforts which produced the reconnaissance maps used as the basis for the more modern work.

"He went on to describe the modern techniques not only for accurate production of contour maps, but also for proving the presence of many minerals below the earth's surface.

"An outstanding example of the value of the latter phase of air survey work, which was mentioned as an adjunct to the paper by Mr. Kendall, is the need

for countries such as Brazil to make greater use of these modern techniques to prove the probable existence of large mineral deposits, in order to attract additional foreign investment capital necessary for the development of those countries.

"In thanking the Lecturer for his stimulating and absorbing paper, Dr. MacPhail, President Elect, pointed out the importance of air survey for accumulating a precise record of our natural resources and indicated the need for greater attention to the recording of engineering and other work, of which the Alexander Graham Bell Museum at nearby Baddeck is an example of the exception rather than the rule.

"Dr. MacPhail also emphasized the examples in this paper of the adage that engineering knows no national boundaries, the specialized equipment having been designed and developed in countries as far afield as Canada, Switzerland and South Africa."

In conclusion the President presented the Certificate and cheque to Mr. Kendall, and the Honours and Awards Session was adjourned.

Abbass

Mr. D. N. Kendall, Turnbull Lecturer

LIST OF MEMBERS

In view of the rather pressing demands for economy, the Council had decided that a List of Members should not be produced in 1959. However the matter was raised at the Annual General Meeting and it was suggested that members might be prepared to pay $1.00 each for a copy of the List; it was decided that the entire membership should be asked, by mail, to express their support or otherwise of this suggestion.

Accordingly cards were sent out early in August and members were asked to reply before the 22nd August. It was necessary to obtain a decision by that date if the List was to be available before the end of the year.

On the 22nd August 247 members had replied stating their willingness to pay $1.00 each for a copy of the List. The break-even point would have been somewhere between 1,300 and 1,500. In these circumstances the List will not be issued this year.

ANNUAL REPORT

Of the Council

1958-59

THE year 1958/59 will be remembered as one of sudden and disturbing events in the evolution of Canadian aviation. Decisions taken by the Government, in the development of national defence policies, have altered the course of the Industy and it is still too early to assess what the ultimate effects will be. In these circumstances, being so preoccupied with the uncertainties of the future, one is apt to overlook the successes of the past; this is a report on the past year and, in many respects, this year, for all its forebodings, has been one of considerable achievement and progress in the short history of the C.A.I.

COUNCIL AND EXECUTIVE COMMITTEE

Firstly, what has the Council been doing? As in previous years, Council meetings have been held at all the major Meetings of the Institute; they have been long meetings with very full agendas, based in the main on work done by the Executive Committee in the preceding months. The Council has met three times, not counting the meeting held on the 14th June, 1959, held jointly with the new Council for a review of the status of unfinished business. The Executive Committee has met six times, including two joint meetings with the Finance Committee. (It will be readily understood that, in the light of recent events, the future of the Institute's finances have been a matter of some concern.)

One of the more important pieces of business has been a study of the Council itself. Under its present constitution the Council increases in size as the Branches increase in size and number and, with the growth of the Institute during the last few years, it has become increasingly difficult for the Council to function as an effective governing body; more and more of the real government has passed to the Executive Committee. This appeared to be an unhealthy trend and a good deal of time has been devoted to an examination of the problem. The subject has been carefully studied by the Executive Committee and debated at the last two Council meetings. The aim has been to evolve a formula, whereby the number of members of the Council will be materially reduced and yet be sufficient to be fairly representative of the membership.

Good progress has been made in reaching a solution and it is likely that the membership will be asked to vote on the necessary changes in the Bylaws, to give effect to these reforms in the coming year. The details have not yet been settled in Council and therefore no more can be said about this matter at the present time.

COMMITTEES

The Council appointed the usual four committees this year—Admissions, Finance, Programmes and Publications—and, in addition, the 50th Anniversary Committee, set up in 1957-58, was reappointed. The Specialist Services Committee and the Long Range Planning Committee were combined and renamed the "Planning Committee". Each committee will report separately but, as agencies of the Council, their work should be briefly mentioned here.

Admissions

The Admissions Committee has been set up in Ottawa, following the practice inaugurated in 1957-58. There it can meet readily and fairly frequently in the Offices of the Institute, with the Assistant Secretary acting as secretary of the Committee. Mr. C. D. Long, a member of the previous Committee, has been its Chairman and its other members have been G/C E. P. Bridgland, Mr. W. F. Campbell and CDR N. A. Smith. Three members constituted a quorum. Meetings have been called by the Assistant Secretary whenever there have been about twenty applications ready for consideration. With the Committee operating in this manner the processing of applications has proceeded smoothly and rapidly.

It is recommended that this arrangement should be perpetuated. Perhaps two members of the Committee should be replaced each year to introduce new blood, two remaining to provide continuity of policy and standard of grading. In any event the Council is well satisfied with the way in which this four-man Admissions Committee has worked.

Finance

This year the Finance Committee has been located in Montreal, under the Chairmanship of Mr. A. E. Ades. Mr. T. A. Harvie and Mr. D. R. Taylor have been its other members, with the Secretary-Treasurer serving ex officio. From the system established by Mr. Dilworth in 1957-58, the budget for 1958-59 was presented to this Committee almost ready-made, and they have been able to follow it closely. Whether their successors will be so well served is another matter; for Mr. Ades' Committee has been faced with an extremely difficult task in establishing a budget for 1959-60. However they have proposed a balanced budget which appears to be sound and practical.

Programmes

Mr. J. L. Orr has served for a second year as Chairman of the National Programmes Committee. The Chairmen of the Branch Programmes Committees have been the other members of the National Committee — S/L W. J. Buchan of Cold Lake, Mr. J. G. Davidson of Winnipeg, Mr. C. E. B. McConachie of Montreal, Mr. A. M. Parry of Vancouver, F/O A. J. Robinson of Edmonton, CDR N. A. Smith of Ottawa, Dr. J. H. T. Wade of Toronto, Mr. R. Wallworth of Halifax-Dartmouth and Mr. J. D. Zmurchyk of Calgary. It must be confessed that, in the opinion of the Council, a Committee so constituted cannot function very satisfactorily as a National Committee — a revised arrangement has been recommended to the new Council — but each member has served his Branch well and, in so far as the Branch programmes are a very important and significant part of the Institute's programme, it can certainly be said that, individually, the members of the National Committee have earned the sincere gratitude of all members of the Institute.

Mr. Orr will report on the programmes of the major Meetings held during the year, but it is perhaps worth emphasizing that the Institute has been

turning a good deal of attention to Astronautics and Space Flight. The technical sessions at the Special Anniversary Meeting in February were devoted almost entirely to this field. It is likely that, with the growing interest in missiles and the like, these subjects will become increasingly prominent in the Institute's activities.

Publications

The Publications Committee must work closely with the Secretary and Mrs. Ross, the Editor of the Journal, and for this reason, in former years, it has been located wholly in Ottawa. With the intention of giving the Committee a rather broader basis, the Council this year appointed two members from outside Ottawa; moreover it appointed a Committee which was representative of various branches of aeronautical endeavour. Mr. R. J. Templin, who was a member in 1957-58, was the Chairman of the 1958-59 Committee, the other members being Mr. J. A. Dunsby and G/C R. M. Aldwinckle of Ottawa, representing Research and the Armed Services respectively, Mr. J. J. Eden of Montreal, representing the Operators, and Mr. F. H. Buller of Toronto, representing Industry.

The month to month production of the Journal lies between Headquarters and the Editorial Board; the Board is consulted about every paper submitted and advises on its suitability for publication. The Publications Committee is consulted chiefly on matters of policy.

The Journal continues to be of great importance in many ways. For members who are not situated within reach of Branches it is almost their only contact with the Institute; it is the Institute's ambassador to technical libraries in many parts of the world; and it is a potential source of income from advertising. It is inevitably subject to a running conflict of criticism and praise, and the Publications Committee must try to satisfy the critics and avoid being lulled into complacency by the flatterers — no easy task.

With regard to the criticisms, which are usually directed at the narrowness of the Journal's "reader interest", it must be remembered that, unlike other types of publication, the Journal does not employ regular, paid contributors chosen for their reputation as interesting writers, but it depends entirely on contributions submitted by people who happen to want to talk about their own work. It is the function of a technical journal to provide such authors with a medium of publication, and conversely, in publishing their work, it should satisfy a wide range of reader interest. If the material is not submitted, in some form however modest, there is very little that the much-maligned Publications Committee can do about it. Every member should bear in mind that his interest in reading the Journal carries a corresponding responsibility for writing some of it.

There is one other point about publications which ought to be mentioned. The List of Members and preprints of papers presented at Institute Meetings have been provided as services to members; but they are extremely expensive luxuries. The Council has decided to discontinue both for the time being, in the interests of economy.

Planning

The Planning Committee is responsible for advising the Council on the long range programme of the Institute's growth, how rapidly the expansion of the Branch and Section structure should be pushed ahead, what projects should be undertaken and the timing of these projects, the development of Headquarters staff and facilities, and a broad, long range budget of the Institute's finances. In addition it is responsible for considering ways and means whereby the services to members may be extended and improved, and for the detailed studies necessary to reduce their schemes to practical procedures.

The Committee was set up this year in Winnipeg, under the Chairmanship of Mr. W. E. Robinson. Mr. C. M. Hovey, Mr. H. W. Grant and, until he left Winnipeg for Montreal, Mr. W. S. Haggett were its members. They inherited a Long Range Plan drawn up to the end of 1961-62 by the 1957-58 Committee but, in the face of the far-reaching changes in the aeronautical climate that have occurred during their term of office, they have been quite unable to adjust the Plan realistically—let alone extend it for another year, to 1962-63, to keep it five years ahead. Perhaps their successors will find more stable conditions on which to rebuild their forecast of future trends.

In its more detailed studies, the Committee has done valuable work in connection with the scheme of Student Awards and Institute Scholarships.

50th Anniversary

The 50th Anniversary Committee can take the credit for this Meeting at Keltic Lodge and for the unveiling ceremony which took place at Baddeck this afternoon. CDR E. B. Morris, the Chairman of the Committee, has been working for this project for two years. His Committee has, of course, been located at the Halifax-Dartmouth Branch and has comprised Mr. E. C. Garrard, CPO R. L. Sabourin and LCDR J. C. Sloan. CDR N. A. Smith in Ottawa has provided an effective liaison between the Committee and Headquarters.

The erection of the monument at Baddeck has been a particularly difficult operation because of the remoteness of the place and the wide distribution of various parts of the work. The Council is most grateful to CDR Morris and his Committee for their efforts. It is perhaps well to remember that this achievement is not only a monument to the Aerial Experiment Association and the Silver Dart but, indirectly, it is a monument to its builders, the Canadian Aeronautical Institute.

HEADQUARTERS

Although the Secretary and his staff of five were kept extremely busy with the general administration of the Institute, the production of the monthly Journal and the rest — they were anything but overstaffed — it has been considered prudent, as an economy measure, to reduce the clerical staff by at least one. Since April they have been trying to reorganize on this basis. One person, remember, represents a 20% reduction and some services will certainly have to be sacrificed.

BRANCHES AND SECTIONS

The new Branch at Calgary, which was established just before this Council took office has made excellent progress and now has a membership of about fifty. The other Branches have also had successful seasons and conducted full programmes of meetings. The Council regrets that it has been unable to render more effective help, through the National Programmes Committee, in arranging for speakers to tour the western Branches or to visit Halifax-Dartmouth; it is admitted that the effort was made too late and the temporary eclipse of Orenda Engines Ltd., in February and March, was also a contributory factor; a speaker from that company had to cancel his engagements when there was insufficient time to find a replacement for him.

The development of Student Sections is proceeding, though not as quickly as the Council had hoped. The Montreal Branch has succeeded in setting up a Student organization, after several years of trying, but this is the only new Section added during the year. However, outside the structure of Student Sections, six Branches have established Student Competitions at the educational institutions in their respective areas. The Council would urge all the Branches to redouble their efforts to interest students in aeronautical engineering and in the Institute. This is a

field which ought to receive the highest priority, because the future of Canadian aviation – and ultimately the future of every Canadian member of the Institute – depends upon the supply of dedicated and qualified young men. Without them Industry and the Operators cannot survive in this very exacting and competitive business, regardless of the economic influences that may be brought to bear.

Of the Specialist Sections, the Astronautics Section has been the most active. The Propulsion Section never quite got into its stride, perhaps because it was not given sufficient play in the programmes of the major Meetings. The Test Pilots Section has contributed materially to the joint I.A.S./C.A.I. Meeting last fall and to the programme of this Annual General Meeting. The Sections are doing good work and it is to be hoped that others will be formed to develop their respective subjects.

MEMBERSHIP

The growth of membership has been encouraging, though it is still too early to determine the effect of the cancellation of the Arrow project and the subsequent loss of technical personnel from the Industry. At the end of March the membership in good standing was 2281, compared with 2121 at the end of March 1958. Death and resignations accounted for 52 members during the fiscal year and, at the end of March, 150 forfeited their membership for non-payment of dues. Today the membership stands at 2302, an increase of 160 over the 2142 at the Annual General Meeting last year.

A recent analysis of members' fields of activity is of some interest, since it gives an indication of the needs that the Institute must endeavour to satisfy in its programmes and publications. The breakdown, made early in April, is as follows:

	Research and Engineering	Production, Maintenance and Operational
Armed Services	7.1%	6.3%
Government Departments	4.7%	2.5%
Aircraft and Missile Mfg.	23.8%	11.8%
Engine Manufacturers	4.0%	3.1%
Accessories and Equipment	9.9%	4.7%
Airlines and Operators	3.6%	4.9%
Students, Sales, Administration and Legal	13.6%	

PROGRAMMES

As usual the Institute has held three major Meetings during the year but, because 1959 is rather a special year, the Mid-season Meeting, usually held at one of the smaller Branches in February, was replaced by the Special Anniversary Meeting in Montreal, and the Annual General Meeting, usually held at one of the larger Branches in May, has been replaced by this Meeting in Cape Breton – perhaps a rather rough approximation to Halifax-Dartmouth. However the I.A.S./C.A.I. Meeting took place in Ottawa on the 7th and 8th October, following established practice.

It was a great pleasure to have Mr. E. C. Wells, President of the I.A.S., present at the Joint Meeting and to see many old friends from the U.S.A., who, as the years go by, are becoming regular and familiar figures at these affairs. It seemed to be the general opinion that the technical standard of the papers presented was higher than usual; this is all to the good.

It is worth mentioning that the Astronautics Section held a meeting in Ottawa on the 9th October and several I.A.S. delegates to the Joint Meeting stayed over for it.

The Special Anniversary Meeting, held in Montreal on the 23rd and 24th February, was perhaps the best Meeting that the C.A.I. has ever staged. It was held, unfortunately, under the shadow of the termination of the Arrow project three days before, and this had a marked effect upon the attendance; even so the registration was 380 and over 700 attended the Dinner. Sir George Gardner of the R.A.E. and Dr. Hugh Dryden of the N.A.S.A. were at the head of a very fine technical programme, which was devoted almost exclusively to the future development of flight both in and beyond the atmosphere. The Dinner was indeed a C.A.I. Dinner, but it was also a national event, co-ordinated with the flight of the fullscale model of the Silver Dart at Baddeck in the morning, so that many of the guests could attend both ceremonies. His Excellency, the Governor-General was the Principal Speaker. Mr. McCurdy was there and other representatives of the Aerial Experiment Association. It was a memorable occasion.

The programme of this Annual General Meeting, though containing an unusual feature in the unveiling of the monument at Baddeck earlier today, is perhaps rather slimmer than usual. In addition to the presentation of the W. Rupert Turnbull Lecture – in itself a fairly substantial contribution – there will be only two technical sessions. But they will be good ones and of topical interest.

The unveiling of the monument at Baddeck, by the Lieutenant-Governor, is now a matter of record. The history of this project is rather interesting. In his Report last year the Chairman of the 50th Anniversary Committee mentioned that the proposed monument would take the form of a scale model of the Silver Dart, mounted on a submerged pedestal in the Lagoon of the Alexander Graham Bell Museum. However this plan was opposed, as a matter of policy, by the Department of Northern Affairs and National Resources, the agency responsible for national parks, and accordingly the Secretary visited Baddeck last summer to look for an alternative location outside the Museum grounds. In the process, he found a friend whom he had not seen or heard of for thirty years, a Dr. Leonard Muller of Miami, who happened to be spending the summer on the Bell estate; in those thirty years Dr. Muller, an architect by training, had married a grand-daughter of Dr. Bell. The Secretary seized the opportunity offered by this most appropriate combination to invite Dr. Muller's help in the design of the pedestal– which had assumed some importance when the Lagoon site had had to be abandoned. Ultimately Dr. Muller submitted a design for the whole thing and it was accepted. In the meantime the Village of Baddeck, supported by Mrs. Grosvenor and Mrs. Fairchild, Dr. Bell's daughters, revived the suggestion that the monument should be placed inside the Museum grounds as the most suitable place, and the Department graciously withdrew its earlier objections. Since then the Department has been extremely co-operative, even enthusiastic, in adjusting its landscaping plans to accommodate the monument and being helpful in every way. The Council would like to express its appreciation at this time.

Generally, on the subject of programmes, as with the Journal there has been some criticism. Constructive criticism is useful and the Council would like to hear more of it; for those responsible for the programme are working very largely in ignorance of the needs and tastes of the membership.

EDUCATION AND TRAINING

The Provincial Committees on Education and Training, set up three years ago, have remained in being, though they have not been very active. It has been their function to be available for consultation by the local educational authorities or to investigate and follow up any points raised by the Council.

However, the Ontario Committee has contributed to the preliminary organization of the new university in Toronto, known as York University; and the British Columbia Committee has given

active support to the Aeronautics Division of the Federal-Provincial Trades & Technical Institute in developing its programme for the training of aircraft maintenance personnel, and has been instrumental in arranging summer employment for students.

It is perhaps questionable whether the Institute can do any more at the present time. A few years ago the need for improved and expanded technical training in this country was stressed by a number of organizations, and some steps were in fact taken. Nothing is to be gained by meddling for the sake of meddling and it seems wise to keep the Institute's Provincial Committees as a force in being, to watch developments and to render help when asked, but not to initiate anything else at the present time.

OTHER SOCIETIES

Turning to the Institute's relations with other societies, reference should be made to three events of particular note.

International Council of the Aeronautical Sciences

Ten delegates from Canada attended the First Congress in the Aeronautical Sciences, held in Madrid from the 8th to the 13th September, 1958. Moreover, a Canadian paper was presented by Professor B. Etkin. In the absence of Dr. J. J. Green, the Secretary represented the C.A.I. at a meeting of the International Council.

Until the next Congress, to be held in Zurich in 1960, Canada's representatives on the International Council will be Dr. Green and Dr. Patterson. During his term of office, Dr. Patterson will have been President and immediate Past President of the Institute; this seems a good arrangement which might be followed in the future.

Engineering and Scientific Luncheon to the Prince Philip

Some time ago the Council sought to invite the Institute's Patron, His Royal Highness the Prince Philip, to participate in some ceremony associated with the Golden Anniversary of Flight in Canada. On other pretexts, other technical societies were trying to arrange for His Royal Highness to address them during the Royal Tour which has just started and, in the end, the Government Hospitality Committee suggested that all these bodies should combine in one "engineering and scientific" event. Consequently, on the 29th June in Toronto, the Prince will be entertained to lunch by the Canadian Council of Professional Engineers, the Engineering Institute of Canada, the Canadian Institute of Mining and Metallurgy, the Chemical Institute of Canada and the Canadian Aeronautical Institute.

Though it is disappointing that it has proved impossible to arrange some purely aeronautical event, it is gratifying that, in this company, the Institute will be able to meet its Patron briefly while he is in the country.

Anglo-American Conference

The Anglo-American Conference 1959 will be held in October, principally in New York. On this occasion the C.A.I. will participate in the series for the first time. Two Canadian papers will be included in the programme and, after the meetings in New York and plant tours in the New York and Cleveland areas, the Conference delegates will come to Toronto for the closing ceremonies. Moreover members of the C.A.I. will be entitled to attend the Conference on the basis of their C.A.I. membership alone; formerly only members of the R.Ae.S. or I.A.S. were so privileged.

It is a great honour to the Institute to be invited to take part in the Conference and it is all the more tragic that, just as the opportunity has come, Canadian research and development should have been so seriously curtailed. It has not been easy to arrange a worthwhile Canadian contribution to the programme in the present circumstances.

REPRESENTATION TO THE GOVERNMENT

In connection with this matter of the curtailment of research and development it is worthy of record that, following the Government's statement of the 23rd September on the Canadian Air Defence Programme, the Council submitted a memorandum to the Prime Minister requesting a clear statement on policy with regard to future research and development and urging that steps be taken promptly to conserve the technical resources of the country in both men and facilities. The memorandum which was sent on the 11th November was published in the December issue of the Journal.

Though the memorandum was acknowledged by the Prime Minister's office and by the other members of the Cabinet to whom copies were sent, no formal reply has been received. However the gesture was made and it may have influenced the Government a little, though the relatively barren policy of "Production sharing" seems to have been adopted with little modification.

ELECTION OF FELLOWS

The annual election of members to the grade of Fellow is a very careful and selective procedure which takes several months to complete. To be eligible a member must have been an Associate Fellow for at least one year. Nominations are put forward by members of the Council and by existing Fellows, and eventually those with sufficient support are submitted to the Council for election, based on an assessment of their contributions to aeronautical science or engineering. A majority vote of the Council is necessary for any candidate to be admitted.

The following were admitted to the grade of Fellow this year;

Mr. D. Boyd
Mr. J. T. Dyment
W/C K. R. Greenaway
Mr. J. Lukasiewicz
Mr. G. D. Watson

NEW COUNCIL

The new President and Vice-President were elected at the meeting on the 14th June, 1959, from among the members of the new Council. These then are the men who will guide the destinies of the Institute in the year ahead:

President – Dr. D. C. MacPhail
Past President – Dr. G. N. Patterson
Vice-President – Mr. D. Boyd

Councillors

Mr. J. P. Uffen (Toronto)
Mr. G. F. W. McCaffrey (Toronto)
Dr. J. H. T. Wade (Toronto)
Mr. E. H. Higgins (Montreal)
W/C C. R. Thompson (Montreal)
A/C W. P. Gouin (Ottawa)
Mr. L. C. Bryan (Vancouver)
Mr. G. W. T. Roper (Vancouver)
F/L J. J. Deslauriers (Winnipeg)
Mr. J. G. Davidson (Winnipeg)
Mr. J. G. Portlock (Edmonton)
F/O A. J. Robinson (Edmonton)
Mr. E. K. Prentice (Cold Lake)
F/L L. S. Lumsdaine (Cold Lake)
Mr. E. C. Garrard (Halifax-Dartmouth)
CDR E. B. Morris (Halifax-Dartmouth)
S/L M. R. Barrett (Calgary)
Mr. W. E. Jamison (Calgary)

The problems facing the new Council are likely to be severe. General conditions will probably deteriorate for some time – or, at best, become more full of doubt and uncertainty. But there are no real grounds for despondency nor any question of the Institute's survival. With wise judgment in the Council and the keen personal interest of every member, the Institute can go forward surely and steadily – if not so rapidly as in the past – and thereby create a confidence in Canadian technical ability, against which the economic storm may ultimately blow itself out. This might well be the Institute's greatest service.

Report of the Admissions Committee 1958-59

The Admissions Committee for 1958-59 was appointed by the President with the following members:

Chairman – Mr. C. D. Long

Members – G/C E. B. Bridgland, Mr. W. F. Campbell, CDR N. A. Smith

Secretary – Mr. H. L. Taylor (1958), Mr. W. A. Chisholm (1959)

Advisor – Mr. H. C. Luttman

The organization and method of operation begun in the previous year was continued: the Committee was entirely composed of residents of Ottawa, and full responsibility was delegated to them by the Council. A further change was made to include a fourth member, and to require a quorum of three; this has facilitated the arrangement of meetings. Eighteen meetings were held during the year, and in only three cases was it necessary to have a member deal with applications outside a meeting. (This compares with eight cases in fifteen meetings the previous year.)

The number of applications dealt with during the year is shown in the following table (compared with the previous year – in brackets).

Seven applications for advancement in grade were turned down.

Thirty-seven applications are awaiting return of reference forms.

	Admissions		Regradings	
Associate Fellow	29	(13)	8	(7)
Member	124	(172)	14	(26)
Associate	15	(17)	1	(1)
Technical Member	111	(107)	33	(19)
Junior Member	6	(10)	7	(8)
Student	59	(45)	Nil	(Nil)
Total	344	(364)	63	(61)

As a result of increasing experience with the problem of assessing such factors as "outstanding contributions" and "recognized standing", the Chairman has proposed to the Council that the Regulations be altered to require more qualified references, particularly for transfers to the higher grades of membership.

Report of the National Programmes Committee 1958-59

The primary function of the National Programmes Committee is the planning of technical presentations at all general meetings of the Institute. In addition, some effort is made to assist the Branches in obtaining speakers. During the past year, on the occasion of the 50th Anniversary of Flight in Canada, special efforts were made to obtain outstanding speakers of national and international repute with gratifying results.

CURRENT ACTIVITIES

The following is a brief résumé of national meetings during the 1958-59 season.

Joint I.A.S./C.A.I. Meeting

In accordance with previous custom, the Joint Meeting with the Institute of the Aeronautical Sciences took place in Ottawa on the 7th and 8th of October, 1958. Sessions included Aeromedicine, Aeroelasticity, Propulsion, Environmental Testing, Actuating Systems, Materials and Test Flying. The principal speaker on this occasion was Mr. Elwood R. Quesada, Chairman of the newly formed U.S. Airways Modernization Board.

Special Anniversary Meeting

On this occasion, the usual Mid-season Meeting was combined with the observance of the 50th Anniversary of Flight in Canada, on the 23rd and 24th of February, 1959, in Montreal. The theme of the technical programme was "The Next Fifty Years of Flight" and the sessions included Atmospheric Flight, Space Flight, Satellites and Propulsion. We were particularly favoured in having papers presented by Sir George Gardner, Director of the Royal Aircraft Establishment, and Dr. H. L. Dryden, Deputy Administrator of the National Aeronautics and Space Administration. At the Anniversary Dinner we were honoured by the presence of the Governor-General, The Right Honourable Vincent Massey, who delivered the principal address, and distinguished members of the official party from Baddeck including the Honourable J. A. D. McCurdy. It is fair to say that this meeting provided the focal point for the 50th Anniversary celebrations and reflected considerable credit upon the C.A.I. as the principal sponsor.

Annual General Meeting

This year the Annual General Meeting takes place in Ingonish, N.S., on the 15th, 16th and 17th of June in connection with the dedication of a monument to the Aerial Experiment Association at Baddeck. In view of the historical ceremonies associated with the occasion, the technical activities are confined to sessions on Flying—Past, Present and Future and Hydrodynamics in addition to the W. Rupert Turnbull Lecture on "Air Survey – The Key to National Resources" which will be presented by Mr. D. N. Kendall.

FUTURE PLANS

The following is a brief outline of future meetings as presently conceived.

Anglo-American Aeronautical Conference

For the first time, the C.A.I. has been invited to participate in the biennial aeronautical conference, organized by the Royal Aeronautical Society and the Institute of the Aeronautical Sciences. The technical meetings will take place in New York on the 5th, 6th, and 7th of October. The C.A.I. is contributing two papers: "STOL Aircraft" by R. D.

Hiscocks of De Havilland and "Hypersonic Studies employing Aeroballistic Techniques" by Dr. G. V. Bull of C.A.R.D.E. During their Toronto visit the delegates will tour the De Havilland plant and the Defence Research Medical Laboratories. The final day coincides with the opening ceremonies of the new laboratories of the Institute of Aerophysics and, through the courtesy of Dr. G. N. Patterson, the delegates will be invited to participate and afforded an opportunity to view the facilities. The foregoing will take the place of the customary Joint I.A.S./C.A.I. Meeting for the year.

Mid-season Meeting

The 1960 Mid-season Meeting is scheduled to take place in Edmonton on the 19th and 20th of February. Programme details have been left open and will be decided by the incoming Committee.

BRANCH PROGRAMMES

The primary responsibility for Branch programmes must always rest with the Branch Executive who are in the best position to assess the interests of their membership. On occasion, the National Committee may be able to assist by suggesting possible speakers or by co-ordinating programmes between adjacent Branches so that advantage may be taken of the presence of outstanding speakers in a particular region.

Last year it was suggested that a circuit tour of the outlying Branches by one or two outstanding speakers should be arranged. Although some attempt was made to accomplish this last fall for the Western Branches it was not actually successful due to prior commitments of the Branch programmes and the difficulty of arranging special meetings on short notice. It is our recommendation to the incoming Committee that plans for tour speakers should be made immediately following the Annual General Meeting so as to enable the Branch programmes to be planned with this in mind.

SYMPOSIA

Following earlier precedent, serious consideration was given to the organization of a Symposium on the "Thermal Effects of High Speed Flight" with participation from both Canadian and U.S. workers in this field. Apart from security problems, the termination of the Arrow project adversely affected the extent of the possible Canadian contribution. Under the circumstances, therefore, it seemed prudent to defer this particular proposal for the time being. However, it is felt that the sponsoring symposia or tutorial seminars on subjects of special interest is a function which the C.A.I. should provide and, as such, is commended to the incoming Committee.

COMMITTEE OPERATIONS

In theory, the Committee consists of all the Branch Programme Chairmen together with a member of the Council as its Chairman. In practice, the exigencies of time and distance require that the executive responsibility be bound primarily by the Chairman, the President and the Secretary.

One formal meeting of the National Programmes Committee was held on the 6th of October last in connection with the Joint I.A.S./C.A.I. Meeting in Ottawa, but the attendance of outside members was disappointingly small. Accordingly, we are recommending that the incoming Council should review the constitution of the National Programmes Committee with a view to establishing a small group able to work in direct contact with the President, the Secretary and each other, so as to deal effectively with the day-to-day problems which inevitably arise.

MEETING MANAGEMENT

Apart from the technical content of our meetings, we believe that there is still considerable room for improvement both in the management of the proceedings and particularly in the conduct of the discussion. These matters are primarily the responsibility of the meeting chairman and we suggest that a set of "Instructions to Chairmen", summarizing the experience of all who have been victimized with this task in the past, would help to raise our standards in this respect.

ACKNOWLEDGEMENTS

It would be unfair to pretend that the success or failure of our national programmes is solely attributable to the efforts of the Committee. In the first place we must acknowledge the major contribution of our speakers, who, voluntarily or otherwise, have devoted so much personal effort to their presentations which, after all, are the foundation of our professional activities and whose quality is the basis upon which the performance of the C.A.I. will be judged. In conclusion, we again pay tribute to the unflagging efforts of our Secretary upon whom the burden of carrying out the Committee plans really falls.

Report of the Planning Committee 1958-59

One of the principal duties of the Planning Committee is to forecast future trends in the aeronautical field, and to plan the Institute's activities approximately five years ahead so that it may serve its members and the science of aeronautics in the best possible measure. Unfortunately, the recent rapid changes, both in government policy and in technology, have been bewildering and have made it quite impossible to consider, seriously, a long range plan of any kind. It has, therefore, neither been practical to modify the previously conceived Long Range Plan inherited by the Committee, nor to extend it for another year, to 1962-63.

The Committee has made a detailed study of Institute Scholarships and Student Awards and has previously made recommendations to Council on these matters. However, in view of the probable financial state of the Institute in the coming year, a reduced program of scholarships seems advisable and detailed recommendations on this basis have now been submitted. It would be premature to discuss them until they have received Council approval.

Report of the Publications

Committee 1958-59

The Publications Committee met four times during the year, and served mainly in a consulting capacity to Mr. Luttman and the editor, Mrs. Ross, who continue to do the really hard work connected with the monthly publication of the Journal.

One of the outstanding problems, a hardy perennial, continues to be the shortage of material for the Journal. It would be pleasant to be able to report that this problem has been solved, but unfortunately such is not the case. The solution, of course, must rest ultimately with the membership. The only part of the problem which can be discussed in Committee is the question of how to find some sort of catalyst which may help to generate, from among the more than 2,000 members and subscribers, the necessary 40 or so articles and technical papers each year which make the Journal possible. If any members thinks that, in view of these statistics, there really should be no problem, undoubtedly our Secretary and Mrs. Ross would be glad to enlighten him further, and would welcome a partial solution in the form of a voluntary written contribution. As a matter of fact, it is difficult even to gather ten good photographs each year for use on the frontispiece page, and yet aeronautics is generally recognized as a photogenic pursuit!

It is probably no secret that many readers feel that their own interests are not satisfied by the papers which are published in the Journal. To some extent this may be inevitable in view of the very wide range of interests represented in the membership, but the Committee have tried not to let this be an excuse for bypassing the question. This problem is, in fact, related to the first because if considerably more material were available for publication it would be possible to exercise more choice in the selection of articles. As a result of discussing the two problems together it was concluded that more contributions should be encouraged under at least two headings. Papers of the review or "state-of-the-art" type, written by experts in particular fields, which do not contain too much technical detail but which describe the stage of progress reached in those fields, are thought to be of wide interest. Almost everyone engaged in aeronautics is a kind of specialist, and most specialists welcome the opportunity to learn how matters stand in other related fields. A second type of paper which is of general interest, but which may be harder to find, is the type which discusses the pros and cons of a technical question which is currently generating controversy. There still remains the problem, however, of digging out the material, and this problem is not yet solved completely.

At an early meeting of the Committee it was decided that, as far as Journal publication was concerned, the most appropriate time to celebrate the Golden Anniversary of Flight in Canada was the anniversary month itself, although it would have been easier in many ways to have put off the special issue until later in the year. The February Journal resulted from these deliberations, and our Headquarters staff came through in the usual efficient manner with a most successful production.

Report of the 50th Anniversary

Committee 1958-59

With your permission we will restrict this report to the monument and to the Annual General Meeting at Keltic Lodge, Ingonish, N.S. As we all know the Dinner in Montreal was a success and the Committee takes no credit for this, the credit going to the Headquarters staff and the Montreal Branch. The Committee did get involved in the ceremonies at Baddeck on the 23rd of February but your Chairman is still not certain which he was representing—the Navy, the C.A.I. or the Golden Anniversary Committee; however, the trips to Baddeck regarding this ceremony allowed many connections to be made that eased the problems involved in building the monument.

The arrangements for the present Meeting and Dinner were in the main the responsibilities of Headquarters, with the Halifax-Dartmouth Branch and this Committee acting as local contacts. As you probably realize by now, Ottawa is almost as local as Halifax.

The monument has been through so many stages during the last two years that it would be pointless to chronicle them all. It is sufficient to say that it progressed from an aluminum replica situated in the middle of the lagoon, through artistic abstracts situated on the side of, or maybe in the way of, the Trans-Canada Highway, to the present monument in the Museum grounds.

If anyone desires a short discourse on the building of a monument and has about a day to spend, we would be very willing to enlighten them. This discourse would cover such points as how deep is a lagoon, the cost of clearing slum areas, the aerodynamics of a stainless steel replica, the effect of off-centre loading on foundations, the cross-section of a stone 5" thick cut at 30° is not 5", the phenomenal price of lime, cement, sand and stonemasons, the local politics

of Baddeck, who pushes the wheelbarrow, that all stones are not good stones, they may be cracked, have igneous inclusions and that the best stones must be in foundations at least twenty years old, that accurate jigs are required if sub-contracted assemblies are to fit, and that the transportation of large packages from Ontario to Cape Breton is not difficult if you have enough friends.

You have all seen the monument and we believe it is attractive and will stand the ravages of time. This Committee can take some credit for the monument; however, it would never have been built without the co-operation of the Department of Northern Affairs who will shortly own the monument.

We would like to thank in particular Mr. Bob Archibald, of the Department of Northern Affairs, for the amount of effort that he put forth in supervising the erection of the monument.

In addition we would like to thank Dr. Leonard Muller, who designed the monument; Field Aviation who made the model, under the guiding hand of Mr. Hawkshaw, their Chief Engineer; Mr. Alphonse McPhee, the stonemason; Chappells Ltd. of Sydney, who erected the foundation, with such speed it must be noted that we could not change our minds once again, although we were trying to do so; the Department of Northern Affairs, who permitted the monument to be erected in its present location and prepared the details of the foundation; the Superintendent of the Naval Base at Sydney for transporting the model from Sydney to Baddeck; and Mr. Donald MacLeod of Baddeck for some of the local arrangements.

We can assure you that during the past two years it has enabled us, as members of the Institute, to fulfill one of the objects of the Institute; namely, the encouragement of education, research and invention!

Report of the Finance Committee 1958-59

The Annual Report of the Council will outline the scope of our activities for the year. However, from a financial standpoint, all functions and activities of prior years were continued and in some cases expanded. The general increase in the Canadian cost spiral, combined with the readjustment familiar to all of us in the Canadian aviation industry, has required the appraising of careful control of expenditure and the use of the Headquarters staff to a maximum efficiency.

The books of account for 1958/59 have been examined by Armstrong, Cross & Company, Chartered Accountants. A copy of their complete report is attached. As may be seen from the Auditor's report, while revenues for the year were slightly lower than expected, expenses were also lower, with revenues exceeding expenses by a comfortable margin.

Advertising Revenue

Advertising revenues from the Journal have declined substantially, but it is anticipated that, with an aggressive promotion policy in action, revenues from this source will improve. The Finance Committee has recommended that accounting methods be amended to identify all overhead costs correctly chargeable to the Journal, so that true total costs can be established with the end objective of achieving a self-sustaining publication.

Sustaining Members

Sustaining Members' contributions were appreciably below that anticipated and an even lower dollar figure has, out of necessity, been forecast for this next year.

Staff Benefits

The Finance Committee, as requested, studied the possible extension of health and retirement benefits for members of the Headquarters staff who are likely to remain permanently in the employ of the Institute. However, the Council quite wisely withheld any consideration of such a program during the present period of financial stress.

THE OUTLOOK

The uncertain situation in the industry, resulting from major changes in the Government's aircraft procurement program, has caused us some difficulty and concern. We are sure that the financial growth of the Institute will be temporarily checked as a result of the reduction of total activity, but we see no reason to alter our basic program objectives associated with the Long Range Plan which was distributed in 1957/58.

Our planning for the coming year contemplates a somewhat reduced budget achieved through economies in administrative and operating expenses, without actually curtailing the program itself.

Sustaining Members' Dues

In reviewing our financial position, we have concluded that next year it will be timely to reduce the load on the Sustaining Members, whose generous support in the formative years made the Institute a possibility. Accordingly, we have developed a proposed schedule of Sustaining Members' dues related to the size and nature of the business. This schedule has been approved by the Council for circulation to the industry. It is also the intention to institute a vigorous campaign among all the businesses in the aeronautical field with a view to securing a much broader – but more equitable – base of industrial support. This program is underway.

Budget For 1959-60

In summary, revenues for this year past exceeded expenses by approximately $3500. A reduced but balanced budget for 1959/60 has been presented to the Council which anticipates that operations can be at the same general level as in 1958/59.

CONCLUSION

In conclusion, we wish to express our sincere appreciation to the Executive Committee who contributed so much of their time and energies during the year in guidance and judgement. Finally, a sincere vote of thanks to our hard working master - of - all - trades Charles Luttman.

AUDITORS' REPORT

To the Members,
Canadian Aeronautical Institute,
Ottawa, Ontario.

We have examined the accounting records of the Canadian Aeronautical Institute for the year ended March 31, 1959, but we did not make a detailed examination of all the transactions in the year.

Subject to the foregoing, in our opinion, the following balance sheet and related statement of revenue and expenses have been drawn up so as to show the true and correct view of the financial condition of the Canadian Aeronautical Institute as at March 31, 1959, and of its operations for the year ended on that date, according to the best of our information and the explanations given to us and as shown by the books.

ARMSTRONG, CROSS & CO.,
Chartered Accountants.

OTTAWA, Ontario,
May 4, 1959.

Statement 1

CANADIAN AERONAUTICAL INSTITUTE
BALANCE SHEET
(exclusive of Specified Funds)
As at March 31, 1959

ASSETS

Current:			
Cash on hand and in bank	$18,323.07		
Less: Due to Specified Funds	356.97		
		$17,966.10	
Accounts receivable		1,858.09	
Hydro Electric Power Commission bonds — 3½% due March 1, 1977		11,970.00	
Accrued bond interest		104.66	
			$31,898.25
Fixed:			
Furniture and fixtures		4,464.33	
Less: Accumulated depreciation		1,882.65	
			2,581.68
			$34,479.93

LIABILITIES AND SURPLUS

Liabilities:			
Accounts payable and accrued charges		$ 2,163.60	
Fees received in advance		861.00	
Journal subscriptions received in advance		183.00	
			$ 3,207.60
Surplus:			
Balance — March 31, 1958		27,745.68	
Add: Net revenue for the year — per Statement 2		3,526.65	
			31,272.33
			$34,479.93

Statement 2

CANADIAN AERONAUTICAL INSTITUTE
STATEMENT OF REVENUE
For the year ended March 31, 1959

Meetings			$ 7,378.68
Publications:			
Journal subscriptions		$ 5,151.71	
Advertising		14,273.52	
Sundry technical papers		928.19	
			20,353.42
Membership:			
Members' dues		16,351.31	
Entrance fees		1,495.00	
Sustaining members		28,170.00	
			46,016.31
Investment:			
Bond interest— Hydro Electric Power Commission — 3½%		420.00	
Bank interest		318.50	
			738.50
Miscellaneous:			
Office supplies		435.09	
Lapel pins		124.00	
Christmas cards and blazer crests		255.35	
			814.44
Total Revenue			75,301.35
Total Expenses — per Statement 3			$ 71,774.70
Net Revenue for the year			3,526.65

Statement 3

STATEMENT OF EXPENSES
For the year ended March 31, 1959

MEETINGS:		
Dinners and facilities	$ 5,726.52	
Printing	1,122.49	
		$ 6,849.01
PUBLICATIONS:		
Journal	18,068.65	
Sundry technical papers	2,581.76	
List of members	1,339.24	
		21,989.65
REMISSIONS TO BRANCHES AND SECTIONS:		
Standard allowances	2,675.83	
Special allowances	173.03	
		2,848.86
MEMBERSHIP ROUTINE		515.65
SECRETARIAT:		
Salaries	25,371.98	
Staff benefits	708.04	
		26,080.02
HEADQUARTERS:		
Rent	4,530.35	
Insurance	8.20	
Telephone and telegraph	804.55	
General maintenance	114.98	
Office supplies	4,085.78	
Exchange and bank charges	224.67	
Legal and audit fees	120.00	
Miscellaneous	455.45	
		10,343.98
TRAVEL:		
Headquarters	1,664.20	
Speakers	36.90	
		1,701.10
CAPITAL EQUIPMENT:		
Provision for depreciation		446.43
50TH ANNIVERSARY MONUMENT		1,000.00
Total Expenses — to Statement 2		$71,774.70

Statement 4

STATEMENT OF SPECIFIED FUNDS
For the year ended March 31, 1959

SCHOLARSHIP FUND:		
Balance — March 31, 1958	$18,000.00	
Interest earned	589.08	
		$18,589.08
AWARDS FUND:		
Balance — March 31, 1958	2,000.00	
Interest earned	147.27	
	2,147.27	
Less: Expended	370.22	
		1,777.05
		$20,366.13
REPRESENTED BY:		
Cash on deposit	$ 1,752.29	
Dominion of Canada bonds — 4¼%, 1972 (par $19,500.00) — at cost	18,256.87	
		20,009.16
Due from General fund		356.97
		$20,366.13

BRANCHES

BRANCH EXECUTIVE COMMITTEES, 1959-60

Branch	Chairman	Past Chairman	Vice-Chairman	Secretary	Treasurer	Councillors
Toronto	Dr. J. H. T. Wade	W. H. Jackson	C. H. Bottoms	C. F. de Jersey 104 Saskatoon Ave., St. Phillips P.O., Toronto 15, Ont.	E. J. Lynch	G. F. W. McCaffrey Dr. J. H. T. Wade Dr. G. N. Patterson J. P. Uffen
Montreal	R. F. O. Smith	W/C C. R. Thompson	F. C. Phillips	W. H. S. Bird 75 Cedar Ave., Pointe Claire, P.Q.	H. H. Whiteman	E. H. Higgins W/C C. R. Thompson* C. M. Newhall** D. Boyd
Ottawa	W/C E. E. McCullough* CDR N. A. Smith**	R. L. Wardlaw	CDR N. A. Smith* G. D. Watson**	W/C A. N. leCheminant 2300 Fox Crescent, Ottawa, Ont.	J. L. Bush	A/C W. P. Gouin Dr. D. C. MacPhail
Vancouver	J. R. S. Hutton	R. J. McWilliams	F. L. Hartley	J. W. Whiskin c/o C. P. A. Ltd., Vancouver Airport, Vancouver, B.C.	W. E. Higgins	G. W. T. Roper L. C. Bryan
Winnipeg	B. W. Torell	E. L. Bunnell	W/C C. J. Evans	N. J. Thomas 439 Linwood St., St. James, Man.	L. T. Deane	J. G. Davidson F/L J. J. Deslauriers
Edmonton	F/L K. Weinstein	C. C. Young	R. W. Van Horne	W. C. W. Mason P.O. Box 121, Edmonton, Alta.	W. C. W. Mason	F/O A. J. Robinson J. G. Portlock
Cold Lake	J. B. Panton	F/L L. S. Lumsdaine	F/L J. A. Bolger	Sgt. J. E. Carson Box 1152, RCAF Stn., Cold Lake, MPO 503, Alta.	F/S T. R. Drinkwater	F/L L. S. Lumsdaine E. K. Prentice
Halifax-Dartmouth	R. Wallworth	CPO R. L. S. Sabourin	LCDR G. M. Cummings	F/L D. W. Cooke 205 School St., Dartmouth, N.S.	J. A. Cornelius	CDR E. B. Morris E. C. Garrard
Calgary	J. D. Zmurchyk	W. A. B. Saunders	H. E. Hampshire	G. H. Ryning 2116 - 6th St. N.E., Calgary, Alta.	G. Fryer	W. E. Jamison S/L M. R. Barrett

*Resigned appointment on transfer. **Appointed to fill vacancy.

All correspondence should be directed to the Branch Secretary at the address shown above.

NEWS

Ottawa

May Meetings

Reported by R. L. Wardlaw

The Annual General Meeting of the Branch was held on 13th May in the RCAF Beaver Barracks. The meeting opened with Mr. H. H. Kelland, Chairman, presiding. He reviewed the Branch activities for the year with brief comments on finances, programmes, membership and the new Educational Committee. The new officers for 1959-60, who were all put in office by acclamation, were announced. Mr. Kelland then handed the meeting over to the new Branch Chairman, W/C E. E. McCullough.

There was no further Branch business to discuss and a talk followed on the Construction and Flight Testing of the Silver Dart II which was given in two parts; the first by F/L W. K. Bell and the second by W/C P. A. Hartman, the pilot of the aeroplane.

W/C McCullough introduced F/L Bell who outlined the aerodynamic and structural analysis, and the resultant modifications required to establish the aircraft's airworthiness. W/C Hartman, also introduced by W/C McCullough, then outlined his experiences in the test flying of the aircraft.

The experience, before the Baddeck flights, with test flights at Mountainview was successful in most respects. Certain problems were encountered, one of the more serious being the restriction that the flights be made over a runway and consequently the pilot had to use more controls than in an unrestricted flight, and the flight time could only be about 50 secs. In all, the ten test flights involved an elapsed time of 3 minutes and 52 seconds. The flights were also seriously restricted by weather conditions, gusts being particularly dangerous with the wing-loading of 2.78 lb/sq ft.

The final aircraft was heavier than the original Silver Dart and had a lower centre of gravity. These changes were due to a heavier engine and more instrumentation. There were also other modifications and the construction in detail was hampered by incomplete drawings for the original machine.

The talks were followed by a movie covering all the aircraft flights including the two Baddeck flights. The second of these involved a serious accident due to a gust. Fortunately, W/C Hartman survived unscathed. This final commemorative flight was made under marginal weather conditions and demonstrated the serious restriction placed on the machine by the weather.

Joint CAI-EIC Luncheon Meeting

On 21st May the Branch, on the invitation of the local branch of the Engineering Institute of Canada, co-sponsored one of the regular luncheon meetings of the EIC at the Chateau Laurier. This was the first luncheon and the first joint meeting attempted by the Branch. The meeting was inspired, in part, by the fact that 1959 is the 50th

anniversary of the founding of the Ottawa Branch of the EIC as well as being the 50th anniversary of powered flight in Canada.

The meeting was presided over by Mr. J. S. Watt, the local EIC Chairman. Also at the head table representing the CAI were W/C E. E. McCullough, Chairman, A/C W. P. Gouin, Dr. D. C. MacPhail, Mr. J. L. Orr, CDR N. A. Smith, and our guest speaker, Air Vice Marshal C. L. Annis, RCAF.

A/V/M Annis was introduced by W/C McCullough and spoke on "Some Aspects of Canadian Aeronautical Development Over a Half-Century". He traced the record of Canada in the field of aviation starting with the work of Turnbull in 1902 and the AEA in 1907-08. Other significant landmarks mentioned were: the great effort of Canada in providing manpower for aircraft in World War I, the design and construction in Canada of five aircraft by Vickers in the 1930's, the tremendous expansion of the aircraft industry in World War II, and the current successes of the Canadian firms. Looking into the future it is best to quote A/V/M Annis' statement " . . . that there is a broad consciousness of the enormously enhanced importance of Canadian research and development as a stepping stone to future Canadian production; and a conviction that the future history of Canadian aviation will turn very predominantly on how well we Canadians exploit our domestic capabilities and potential in this regard in the months and years that lie ahead".

A/V/M Annis was thanked for his excellent talk by Mr. J. S. Watt of the EIC. There were about 100 present at the meeting.

June Meeting

Reported by W/C A. N. le Cheminant

The last Ottawa Branch function for the 1958-59 season took the form of a field visit to RCAF Station Uplands. By kind permission of the Commanding Officer G/C C. M. Mussels the tour consisted of visits to the following:

Operations Room
Navigation Section
Instrument Development Section
Aerodynamics Section
Electronics Section
Airworthiness Section
Airworthiness Workshops

Some sixty members and eleven guests assembled at the Officers Mess at 8 pm on Wednesday 10th June where they were welcomed by S/L Herbertson, the station P.R.O. His happy knack of putting people at ease while emanating more than a modicum of cheerful enthusiasm launched the party into two 40 seat buses en route for the Operations Room

Here in an atmosphere of readiness we were briefed on the role of the CF-100 Squadron stationed at Uplands together with the organizational layout of the Station itself. Some forty minutes later the party strolled along the tarmac to the well lighted vastness of the new hangar which provides home for the Central Experimental and Proving Establishment (CE and PE). Here we were met by the Commanding Officer G/C MacWilliam, who briefly outlined the purpose and some of the jobs of CE and PE. The party was then divided into five groups, each with a Squadron Leader guide for the tour of the sections. Unadvertised but possibly the highlight of the evening was a tour through an Argus anti-submarine patrol plane, Canadian version of the Britannia. The apartment building size of the machine does not become apparent until after entering but from here on in the characteristics seem to stem from the depths of a modern warship rather than the popular conception of an airplane. The depth charge dropping chute, the blacked out 'ops room' and its row of seats through the crew quarters to the flight deck gave one just a little idea of the magnitude of the effort that has gone into this modern U boat hunter.

With only small jams the guides managed to steer their groups through the compact sections and observe the great range of equipment, personnel and background which the RCAF has managed to gather under one roof.

Return to the mess for a nightcap and genuine hearty vote of thanks to those responsible wound up a most interesting and impressive evening.

Toronto

Reported by Dr. J. H. T. Wade

May Meeting

The Annual General Meeting of the Toronto Branch was held at the Elms Golf and Country Club on Thursday, 14th May.

An excellent dinner was served to 80 members, followed by the Chairman's report, the reports by the various Committee Chairmen and the presentation of prizes to the winners of the Student Thesis Competition. These prize winners were: Mr. J. G. Framboise, University of Toronto; Mr. R. A. Cook, Ryerson Institute of Technology and Mr. P. Dzulinsky, Central Technical School.

Mr. W. H. Jackson then introduced the Executive elected for the 1959-60 season including the two Councillors who will represent the Toronto Branch for the next two years. In introducing the new Councillors, Mr. Jackson stated the Toronto Executive desired that the Branch Chairman should automatically represent the Branch in Council.

Mr. R. D. Hiscocks, Assistant Chief Engineer, De Havilland, entertained the members with a well illustrated talk in which he described the development of the Caribou aircraft. The speaker told of the reason behind the selection of the Caribou configuration, and desirability for the novel model tests undertaken by De Havilland aerodynamicists using models both on a truck and "piggy-back" on an Otter aircraft. Mr. Hiscocks ended his witty discourse by showing graphs depicting the aircraft's impressive performance.

Halifax-Dartmouth

Reported by J. W. Milman

May Meeting

The May meeting of the Branch was held in the cinema of the Chief Petty Officers' Mess, HMCS "Shearwater", on Wednesday 20th May, 1959. A total of 40 members and guests were present. The Branch Chairman, Mr. R. Wallworth, was in the chair.

As this was the first meeting since the Branch Annual General Meeting, the Chairman opened by introducing the officers and chairman of committees to the meeting. The Chairman reminded the meeting of the Annual General Meeting of the Institute to be held at Keltic Lodge, Ingonish, N.S., on the 15th, 16th and 17th June.

The speaker for the evening, CDR C. W. Ross, R.C.N., Manager, Electrical Engineering Department, H.M.C. Dockyard, Halifax, was introduced by the Chairman.

CDR Ross presented a paper entitled "Electricity and Weapons System". CDR Ross opened by stating the development of weapons systems, from the caveman's club to the latest anti-missile missile, was the story of man's technological progress. Electricity of course has been one of the main contributors to this progress, particularly in recent years. He then gave a short history of the progress of electricity in Naval weapons from when it was first used in gun-firing circuits, through search lights, gun control to the present day systems.

CDR Ross then explained the age-old weapons system problem in modern nomenclature and showed how any weapons system could be broken down into several basic stages, namely: Detection, Designation, Acquisition, Tracking, Prediction and finally Kill. The

main difference between various weapons systems being in how the problem was solved and on which phases the emphasis was placed. He then considered each stage in more detail and explained where electricity and electronics played a significant part.

Finally, CDR Ross stressed that the perfect weapons system performs all the required functions in zero time and with zero error. At the same time the system must be easy to test and maintain. "Fabulous improvements have taken place over the years but it is still a long hard path to the perfect weapons system."

After a brief intermission, a very interesting question period followed, during which the speaker answered many questions presented by the members and guests. The speaker was thanked by Mr. G. Stewart.

Winnipeg

Reported by G. Milner

June Meeting

A meeting of the Winnipeg Branch was held in the Paddock Restaurant on the 9th of June at which 60 members and guests were present.

The Chairman, Mr. E. L. Bunnell, introduced the new Executive and in the absence of Mr. B. W. Torell, the new Branch Chairman, turned over the business portion of the meeting to W/C C. J. Evans.

The speaker of the evening, Mr. R. Turner, President of TransAir Limited, was introduced by Mr. F. Pink of T.C.A. Mr. Turner spoke on the subject of "The Small Aircraft Carrier Industry in Canada".

(*Mr. Milner's summary of Mr. Turner's lecture is rather long for this section of the Journal but it is of considerable interest and is reproduced in full in the Technical Forum on page 276.–Sec.*)

At the conclusion of the meeting Mr. D. A. Newey thanked the speaker for a very interesting address.

SECTIONS

SOME SUGGESTIONS

by the Secretary

I am always keeping my eyes and ears open for new subjects for Specialist Sections. I think that the Sections we have, though their administration is still rather unsatisfactory, are doing a great deal to further their respective causes; they focus our attention and our efforts and, led by experts in their fields, they ensure a fairly high standard of papers and discussions. A few more Sections would be a great asset.

Historical

There has been so much history talked during this year that the historians have had a field day. History is a great teacher and I think it would be a pity if we were to allow this year to pass without making some effort to keep this interest in history alive. I could list half a dozen of our members who are keen historians and no doubt there are others who have not seen fit to enter the various arguments that we have had during the year. Are there enough all told to form a Historical Section?

Man-powered flight

In these days when we are all contemplating the thrill of being rocketed into space, it is refreshing to find that quite a lot of people would like, quite simply, to fly like a bird. A group of enthusiasts in England formed the Man-powered Aircraft Committee (MAPAC) two years ago and this has now been accepted as a "Group" of the RAeS I know of a few people in the Institute who are interested in the subject and, with some of our Soaring Association members, they might form the nucleus of a Man-powered Flight Section. This month's Technical Forum (page 275) contains a good example of the sort of discussion that such a Section would promote.

Helicopters

It would be interesting to have some discussion about the desirability or otherwise of forming a Helicopter Section. In the USA the American Helicopter Society works, I believe, in close concert with the IAS and this would justify our forming a Helicopter Section if the numbers warranted it. But should such a Section be formed on a broader basis? Should it be called a VTOL Section? I believe that the true helicopter man would say 'no' but it is going to be difficult to define the scope of the Section if we are to exclude rotodynes, tilt wings and various other VTOL configurations.

R.S.V.P.

These ideas are not entirely my own; for example, two people have asked me about the formation of a Historical Section and I have promised to mention the subject to find out what the reaction would be. If any member has some comments on any of these three suggestions – Historical, Man-powered Flight or Helicopters – I should be very glad to hear from him.

Test Pilots

Annual report of the Executive Committee 1958-59

During the past year the Test Pilots Section continued to work on the problem of jet instrument ratings for civilian pilots, acquiring new members and organizing sessions featuring test piloting subjects at CAI meetings.

Section spokesmen were appointed to maintain liaison with their respective CAI Branches. The intention was to make the Section more effective in action and the work of the Publications Committee has continued to help in this respect.

It was proposed that a Test Pilots course, sponsored by industry and government, be established. The state of the industry forestalled any effective progress and further action on this matter is passed on to the new Executive.

S/L O. B. Philp and Mr. R. J. Baker have been elected Chairman and Vice-Chairman, respectively, for the 1959-60 season. F/L R. H. Janzen, who was elected Secretary-Treasurer, was posted to the United Kingdom and was unable to accept the position; the name of his replacement is to be announced at a future date.

The Society of Experimental Test Pilots (SETP) has proposed discussions with the Test Pilots Section regarding possible forms of collaboration which could benefit both organizations. The SETP had invited the Section's Chairman this past spring to attend a Symposium held by them at the First World

Congress of Flight. The CAI offered its support to the Section to make it possible for the Chairman to attend but his other commitments regrettably made the trip impossible. It is expected that the SETP will make further approaches to the new Executive.

The retiring Executive offers its thanks to the membership for its cooperation and all the personal help offered. It is most grateful to Don Rogers for his help to this Executive when it first took office.

ASTRONAUTICS

Annual report of the Executive Committee 1958-59

The Astronautics Section started its official business in the fall of 1958, after a preliminary committee worked out Section Regulations details in the spring of 1958.

Membership

Forty-one CAI members were members of the Astronautics Section when the first executive took office on October 9th, 1958. The present membership is eighty-four, geographically located as follows:

Ottawa 30; Toronto 17; Winnipeg 1; Vancouver 2; Halifax-Dartmouth 1; Montreal 28; Quebec 1; Cold Lake 1; Tullahoma 2; Washington, D.C. 1.

The Section is attracting engineers and scientists from branches of science and technology not directly concerned with airplanes, and thus the Section contributes to a widening of the interest of the Canadian Aeronautical Institute.

Executive Meetings

The Executive of the Section met on the following dates:

October 8, 1958, Ottawa
December 5, 1958, Ottawa
February 23, 1959, Montreal

Section Meetings

October 9, 1958,
RCAF Officers' Mess, Gloucester St., Ottawa.

This first meeting of the Astronautics Section consisted of a business session, in which the aims of the Section were discussed and the new Executive was installed, and a technical session. The following papers were delivered at this meeting:

W. F. Campbell – The Clock Paradox
Dr. H. S. Ribner – Propulsion Systems for Space Travel
D. Bogdanoff – Guidance and Control

February 24, 1959,
Queen Elizabeth, Montreal

At the special Anniversary meeting of the CAI the Astronautics Section organized a luncheon meeting with guest speaker Dr. J. F. Heard on "The Physical Nature of the Planets and their Probable Course of Evolution".

This luncheon was co-sponsored by the Propulsion Section.

June 16, 1959,
Keltic Lodge, Ingonish, N.S.

A business session scheduled for the Annual General Meeting failed to draw a quorum. Instead, Dr. H. J. Luckert, representing the newly elected Executive, held informal discussions with Dr. H. S. Ribner, representing the retiring Executive, and with Mr. F. H. Keast, new Chairman of the Propulsion Section.

Executive Committees

(i) Retiring

Dr. H. S. Ribner (UTIA) Chairman
Mr. D. Bogdanoff (Canadair) Vice-Chairman
Mr. J. A. van der Bliek (NRC) Secretary-Treasurer
Mr. W. F. Campbell (NRC) Past-Chairman

(ii) Incoming

Mr. D. Bogdanoff (Canadair) Chairman
Dr. H. J. Luckert (Canadair) Vice-Chairman
Dr. D. G. Gould (NRC) Secretary-Treasurer
Dr. H. S. Ribner (UTIA) Past-Chairman

Branch Activities

(i) Ottawa

February 2, 1959

A Special Meeting, outside the normal programme of the Ottawa Branch was held to hear Mr. J. Lukasiewicz speak on the subject "Experimental Investigation of Hypervelocity Flight". Mr. Lukasiewicz described some of the work and extensive equipment of the Gas Dynamics Facility of ARO, Inc. It was a most interesting and well illustrated talk.

April 8, 1959

Dr. H. F. Dunholter repeated to the Ottawa Branch the address entitled "The Space Race" which he had delivered the day before in Montreal. (This was a good example of the liaison between Branches that the Section can provide.)

(ii) Montreal

November 12, 1958

The Montreal Branch of the CAI was addressed by W. H. Patterson, Assistant Chief Manager, Convair Astronautics, on "Future Programs in Interplanetary Research". A film on an Atlas firing was shown. Mr. D. Bogdanoff, Vice-Chairman, representing the Astronautics Section at the head table, introduced and thanked the speaker.

April 7, 1959

The first dinner meeting of the Astronautics Section was held at Canadair. Dr. H. F. Dunholter, Assistant Chief Engineer (Development), Convair Astronautics, San Diego, spoke on "The Space Race" and showed a film in colour on the countdown procedure for Atlas.

(iii) Toronto

The UCLA film lecture series on "Space Technology" was brought to the attention of the Extension Department, University of Toronto, in part through the efforts of Dr. H. S. Ribner who viewed the series in Cleveland last summer and reported to Dr. G. N. Patterson. This series was presented by the Department at Carleton University, University of Toronto and McMaster University.

March 19, 1959

Mr. W. E. Moeckel, Chief, Advanced Propulsion Section, NASA, spoke on "Propulsion Methods in Astronautics". The meeting was sponsored jointly by UTIA, the Astronautics Section, the Toronto Branch and the Canadian Astronautical Society.

April 14, 1959

Dr. C. S. Draper, Head of the Department of Aeronautics, MIT, spoke on "Inertial Guidance". This meeting was co-sponsored by the Canadian Astronautical Society, the Astronautics Section and the Toronto Branch.

Forthcoming Meeting

The Astronautics Section will sponsor two technical sessions on Astronautics at the UTIA Decennial Symposium to be held October 14th-16th, 1959, in Toronto.

Treasurer's Report

During 1958-59 the Executive did not incur any expenses. Since each CAI Section will be paid $25.00 per year by CAI Headquarters, a request has been forwarded to Mr. Luttman to reserve that amount for future purposes.

Relevant or Sponsored Articles in the Canadian Aeronautical Journal

November, 1956, p 341 On CAI Specialist Sections
September, 1958, p 256 On the formation of the Astronautics Section
November, 1958, p 316 "The Clock Paradox" by W. F. Campbell
November, 1958, p 339 Report of the first meeting, Astronautics Section, Ottawa, October 9, 1958.

December, 1958, p 374 Report on the Montreal Branch, November Meeting

March, 1959, p 81 Editorial: "Toward a Space Program for Canada" by Dr. H. S. Ribner

April, 1959, p 163 Report of Specialist Section Luncheon, Montreal, February 24, 1959

May, 1959, p 184 "The Physical Nature of the Planets and their Probable Course of Evolution" by Dr. J. F. Heard

May, 1959, p 203 Report of the Montreal April meeting of the Astronautics Section

Appreciation

The Astronautics Section Executive wishes to thank Mr. Luttman and his staff for the extensive assistance received in organizing the Section. We have been impressed by the efficient and pleasant manner in which the Sections affairs were treated.

Future Plans and Activities of the Executive Committee 1959-60

The new Executive took office formally on June 16, 1959. It is only appropriate to convey, on behalf of the Astronautics Section, the sincerest thanks to the outgoing Executive, and particularly to the Past Chairman, for all their efforts and the wonderful job they have done. Considering the short time which has elapsed since the Section came into being in October last year, and that the start of a new organization is not too easy, very much has been achieved. This is also expressed in the message of the new Chairman:

> "The activities of the Astronautics Section during the past year have done much to promote interest in Canada in the field of Astronautics and to forward Canada's active participation in the field of Upper Atmospheric Research and Astronautics in general.
>
> "It will be the aim of the Executive in the coming year to further this good work by pursuing the twin objectives of crystallizing Canada's position in the field and by pushing forward logical plans for a Canadian experimental program."

The plans for the coming year are manifold.

Forthcoming Meeting

Arranged by the outgoing Executive, two technical sessions on Astronautics subjects will be sponsored by the Astronautics Section at the UTIA Decennial Symposium in Toronto. An afternoon session on Thursday, October 15th, and a morning session on Friday, October 16th, 1959, have been arranged, when a total of seven technical papers will be presented.

Astronautics Section Symposium

The Section plans to sponsor a High Altitude Experimental Symposium, in which a program for high altitude research in Canada would be discussed. It would be advisable to hold such a symposium as early as possible, and a tentative date of December this year has been fixed.

Annual General Meeting

The Astronautics Section is planning to sponsor a half day session at the Annual General Meeting of the CAI in May, 1960, in Ottawa. The session would comprise three papers on topics relating to Astronautics.

Local Activities

(i) At least one meeting with a lecture in the field of Astronautics should be held in the frame of the local Branch program. Efforts are being made to arrange for a speaker to address the Montreal, Ottawa and Toronto Branches, in February or March, 1960. Consideration has also been given to obtaining a speaker from Boeing, Seattle, to address the Vancouver, Calgary and Winnipeg Branches of the CAI, in order to promote the ideas of the Astronautics Section in these areas.

(ii) The formation of local specialist Groups within the Branches is highly desirable. According to the Regulations, these local Groups can be formed if at least five CAI Branch members belong to the Astronautics Section. At present, Montreal, Ottawa and Toronto fulfil this requirement, and the formation of Groups in these Branches should be encouraged. It is thought that these local Groups should meet frequently for informal discussion on topics relating to Astronautics. In this way the interest in various fields of Astronautics could be furthered and widened, and it is expected that these informal get-togethers may be of value to the members of the Astronautics Section.

Conclusion

In conclusion it may be said that efforts have been made to lay down the program for the coming year; it is hoped that, with the cooperation of all members, satisfactory progress in the objectives of the Astronautics Section can be obtained.

PROPULSION

Annual Report of the Executive Committee 1958-59

During the past year, our first as a Specialist Section of the CAI, we have accomplished some of our objectives and fallen short of others. I will review for you our position and where we hope we will be able to go in the future.

Our objectives have been:

(a) To assemble a good representation of the people in Canada contributing to the propulsion field.

(b) To provide a focusing agency through which these people can meet and discuss their problems and experiences.

(c) To collect papers for presentation to propulsion people and the CAI generally, to better acquaint members with work being done in propulsion and with future plans and trends.

(d) To assist the CAI nationally and in the Branches by helping with planning, participating on committees and providing specialist services.

To achieve the first objective, a Membership Committee was formed last fall. This Committee, chaired by Mr. D. E. Morrison, the Past Chairman, was composed of representatives picked from the Section membership in Winnipeg, Toronto, Ottawa and Montreal. A list of CAI members responsibly employed in the propulsion field has been made up and a very few people on this list have been asked to join the Section. Progress in this area suddenly stopped on February 20th with Mr. Morrison's resignation from the Committee, but we recommend that this basic task be completed by the incoming Executive.

The Section membership has only increased by about 25% since the last Annual Meeting. It does not appear that many of our members have departed to the U.S. since February 20th (only two are known by the Chairman) and we hope that this will remain the case.

Although the Section co-sponsored a luncheon at the 50th Anniversary Meeting in Montreal and helped organize a Propulsion Session at the October Meeting in Ottawa, very little else was done to accomplish the second objective of providing a 'focusing' agency for propulsion people. After the Section membership is consolidated it might be possible to organize get-togethers, news letters etc, which would increase the feeling of community among Canadian propulsion specialists.

During the past year, this Section has obtained one paper that was presented at the October Meeting in Ottawa. There is a great opportunity here to increase the number of papers on propulsion topics. When our membership covers our field in Canada more thoroughly than at present, it is hoped that we will be able to provide the National and Branch Programmes Committees with many speakers and articles.

The Propulsion Section has assisted the CAI to some extent by suggesting means for the propulsion department of the Editorial Board, which screens papers for the Canadian Aeronautical Journal. We have also received books to review.

Since a broader base of membership seems necessary for a more effective Section, I would like to suggest that all present members go out of their way to urge other propulsion people to join the Section.

MEMBERS

NEWS

S. L. Britton, F.C.A.I., has been appointed Deputy Chief Engineer in charge of the Atomic and Industrial Engineering Division of Orenda Engines Limited.

Dr. J. J. Green, F.C.A.I., has been appointed Chief Superintendent of Canadian Armament Research and Development Establishment.

F. H. Keast, F.C.A.I., as been appointed Technical Director of Orenda Engines Limited.

Dr. G. N. Patterson, F.C.A.I., has been appointed University Representative to the Associate Committee on Space Research.

G. D. Watson, F.C.A.I., has been appointed Associate Committee Member of the Associate Committee on Space Research.

B. A. Avery, A.F.C.A.I., has been appointed Chief Engineer of Orenda Engines Limited.

V. E. Crompton, A.F.C.A.I., has been appointed Chief of Engineering Services at Orenda Engines Limited.

Dr. A. L. M. Grzedzielski, A.F.C.A.I., has recently taken a position as Associate Research Officer with the National Research Council.

Maj. J. H. Harrop, A.F.C.A.I., has left Avro Aircraft Limited to take up a position as Planning Supervisor (Special Projects) with Atomic Energy of Canada Limited at Chalk River.

E. Kosko, A.F.C.A.I., has joined the staff of the National Research Council as an Associate Research Officer.

J. P. Laviolette, A.F.C.A.I., has been appointed Chief Aero Products Engineer at Orenda Engines Limited.

C. D. Long, A.F.C.A.I., formerly with Spartan Air Services Ltd., has joined the Ottawa office of De Havilland Aircraft of Canada Ltd. as Technical Representative.

Dr. P. M. Millman, A.F.C.A.I., was recently elected a Fellow of the Royal Society of Canada.

A. L. Sutton, A.F.C.A.I., has been appointed Deputy Chief Engineer in charge of the Aeronautical Engineering Division of Orenda Engines Limited.

D. R. Taylor, A.F.C.A.I., has been elected to the Board of Directors of Aviation Electric Limited and appointed a Vice-President of the company.

F. R. Thurston, A.F.C.A.I., has been appointed Associate Committee Member of the Associate Committee on Space Research.

M. Arendarski, M.C.A.I., has recently taken a position as Design Engineer with the National Water Lift Company in the United States.

L. Badone, M.C.A.I., was recently appointed Research Fellow at the Physical Metallurgy Division, Department of Mines and Technical Surveys.

W. H. Beresford, M.C.A.I., has recently taken up the position of Structures Engineer at North American Aviation Inc., Columbus, Ohio.

W. Farrance, M.C.A.I., was recently appointed Manager of Martin-Baker Aircraft Company, Collingwood, Ontario.

D. F. Freshwater, M.C.A.I., has recently taken up the position of Senior Design Engineer at Lockheed Aircraft Corporation, Columbus, Ohio.

R. E. Hobbs, M.C.A.I., has taken up the position of Senior Liaison Engineer with the Lockheed Aircraft Corporation, Marietta, Georgia.

J. V. Iorns, M.C.A.I., has recently taken a position as Senior Aircraft Engineer with the Lockheed Aircraft Corporation, Marietta, Georgia.

P. R. Payne, M.C.A.I., was recently appointed President of Avian Industries Limited, a newly formed company.

F. T. Purvis, M.C.A.I., was recently appointed Chief Industrial Products Engineer at Orenda Engines Limited.

R. B. Shannon, M.C.A.I., has recently taken up the position of Senior Design Engineer at North American Aviation Inc., Columbus, Ohio.

H. R. Smith, M.C.A.I., has left Dosco to take up the position of Executive Vice-President (Aeronautical), of A. V. Roe Canada Limited.

R. F. Thomson, M.C.A.I., has recently taken the position of Assistant Senior Engineer with Aerojet-General Corporation.

L. B. Walker, M.C.A.I., was recently appointed Manager of Research and Product Engineering at Canadian Car Company Ltd.

W. S. Bellian, Technical Member, has been appointed Chief of Aero Service at Orenda Engines Limited.

K. F. MacPherson, Technical Member, has recently taken a position as Designer with Bendix Aviation Corporation, South Bend, Indiana.

J. P. Mentick, Technical Member, has recently taken a position as Design Engineer with the New York Air Brake Company.

G. B. Sampson, Technical Member, was recently appointed Director of Avian Industries Limited.

ADMISSIONS

At a meeting of the Admissions Committee, held on the 20th May, 1959, the following were admitted to the grades shown.

Associate Fellow

J. E. Griffiths, Technical Liaison Manager, Teddington Aircraft Controls Ltd., Merthyr Tydfil, South Wales: *92 Penton Rd., Staines, Middlesex, England.*

Dr. P. M. Millman, Head of Upper Atmosphere Research Section, National Research Council, Ottawa, Ont.

A. B. Oxley (on regrading from Member)

Member

G. L. Cannam, Maintenance Supervisor (Assistant), Pacific Western Airlines, Edmonton, Alta.: *11715 - 133 St., Edmonton, Alta.*

W/C E. Miall, RCAF, Branch Head – Aircraft (Reciprocating), AMCHQ, Ottawa, Ont.: *418 Third Ave., Ottawa, Ont.*

J. K. Sobieski, Senior Engineer, Canadair Ltd., Montreal, P.Q.: *60 Brookhaven, Dorval, P.Q.*

J. Thompson, Stress Engineer, De Havilland Aircraft of Canada Ltd., Downsview, Ont.: *19 Amaron Ave., Thistletown, Ont.*

J. C. Uhlman, Director, Manitoba Government Air Service, Box 39, Lac du Bonnet, Man.

Prof. J. H. T. Wu, Dept. of Mechanical Engineering McGill University, Montreal, P.Q.

Technical Member

A. G. Bright, Project Engineer, Canadian Pratt & Whitney Aircraft Co. Ltd., Montreal, P.Q.: *1444 Grant, Apt. 4, Ville Jacques Cartier, P.Q.*

LSAR D. A. Gillis, RCN, Air Rigger, HMCS Shearwater, N.S.

B. H. Jones, Quality Engineer, Bristol Aero-Industries Ltd., Montreal, P.Q.: *5975 25th Ave., Apt. 3, Rosemount, Montreal 6, P.Q.*

F/O W. Neimy, RCAF, Pilot, RCAF Stn. Bagotville, P.Q.: *c/o Officers' Mess, RCAF Stn. Bagotville, P.Q.*

J. B. Rensen, Quality Control Inspector, Canadair Ltd., Montreal, P.Q.: *1480 Decarie Blvd., Apt. 32, St. Laurent, Montreal, P.Q.*

F. E. Roy (on transfer from Student)

Junior Member

F/O A. S. Armstrong (on transfer from Student)

Miss M. R. Walton (on transfer from Associate)

Associate

S/L E. P. Wood, RCAF, Staff Officer Intelligence, ADC HQ, RCAF Stn. St. Hubert, P.Q.

* * *

At a meeting of the Council, held on the 14th June, 1959, the following admission was approved.

Member

Dr. J. C. Arnell, Scientific Advisor to the Chief of Air Staff, AFHQ, Ottawa, Ont.: *95 Carling Ave., Ottawa, Ont.*

* * *

At the meeting of the Admissions Committee, held on the 27th May, 1959, the following were admitted to the grades shown.

Associate Fellow

Dr. B. G. Newman, Professor in Fluid Mechanics, Laval University, Quebec, P.Q.: *148 Route de L'Eglise, Ste. Foy, P.Q.*

Dr. G. V. Parkinson, Associate Professor of Mechanical Engineering, University of British Columbia, Vancouver, B.C.

R. Van Toen, Group Leader, Weight Control, Canadair Ltd., Montreal, P.Q.: *Box 208, Rosemere, P.Q.*

Member

H. L. Baedak, Airline Captain, Canadian Pacific Air Lines, Edmonton, Alta.: *8543 - 67th Ave., Edmonton, Alta.*

W. Bennett, Development Project Engineer (Test), Orenda Engines Ltd., Box 4015, Terminal A, Toronto, Ont.

G. R. Salter (on regrading from Technical Member)

A. Wharton, Experimental Officer, Royal Aircraft Establishment, Farnborough, Hants, England: *Banff, Court Moor Ave., Fleet, Hants, England.*

Technical Member

W. S. Brown, Test Pilot on Helicopters, Genaire Ltd., St. Catharines, Ont.: *331 Archibald Ave., Renfrew, Ont.*

A. King, Project Engineer, Genaire Ltd., St. Catharines, Ont.: *483 Simcoe St., Niagara-on-the-Lake, Ont.*

Dr. R. H. Levy, Engineer, Canadair Ltd., Montreal P.Q.: *3477 Drummond St., Montreal 25, P.Q.*

J. Mullins, Nova Scotia Technical College, Halifax, N.S.: *35 Popular Rd., Cornerbrook, Newfoundland.*

S. C. Ward, Sales and Service Representative, Aviation Electric Pacific Ltd., Calgary, Alta.: *4 Hoover Place, Calgary, Alta.*

D. M. Waters, Engineer, Canadair Ltd., Montreal, P.Q.: *2240 Goyer St., Montreal 26, P.Q.*

Student

J. L. Drolet, University of Toronto, Toronto, Ont.: *75 Herbert Ave., Toronto 8, Ont.*

C. H. Siebs, Provincial Institute of Technology & Art, Calgary, Alta.: *P.O. Box 694, Calgary, Alta.*

D. R. Wilder, Sir George Williams College, Montreal, P.Q.: *1441 Drummond St., Montreal, P.Q.*

Associate

J. A. Miles, Commercial Supervisor, S. Smith & Sons (Canada) Ltd., 105 Scarsdale Rd., Don Mills, Ont.

BOOKS

PMM — Applied Mathematics and Mechanics, Vol. 22, No. 1. Russian Journal translated by GEORGE HERRMANN. Pergamon Press, London and New York, 1958. $35.00 per volume, bi-monthly.

The Canadian Aeronautical Institute has received a translation of an introductory issue of the Russian Journal of Applied Mathematics and Mechanics which appeared in the USSR during 1958. Since this issue is believed to be the first of a series, a review of some of the papers of particular interest to the aerodynamicists has been prepared.

The theory of strong blast waves initiated at a point source and travelling into a compressible medium is worthwhile commenting on. The cases of plane, cylindrical and spherical blast waves are treated by a unified approach which appears to be an extension of an earlier Russian paper concerned with the propagation of blast waves into an incompressible medium. The author is mainly interested in formulating general conditions on the equations of state and the internal energy of the fluid so that dynamically similar solutions of the equations of motion can be obtained. The nature of the solution is discussed by examining the type of singularity occurring in the differential equations governing the flow. The theory is applied to a number of separate cases.

A series of problems concerning the optimum flight programming of space rockets are treated by a method based on general variational principles. The type of problem considered is to find the trajectory for

(1) reaching a specified altitude with least fuel consumption;
(2) reaching maximum altitude with given fuel expenditure;
(3) attaining maximum speed at a prescribed altitude.

The method is also applied to find the best shape of a frictionless, rigid launching track (ramp) of given height. It is shown that in many cases the optimum trajectory is that which starts or terminates in a horizontal or vertical flight path and there may be abrupt changes in flight direction.

Another paper deals with the calculation of lift and pitching moment of low aspect ratio wings with swept leading edges having nacelles at the tips. The nacelles are considered to be bodies of revolution whose axes are parallel to the plane of symmetry of the wing. The theory applies primarily to the subsonic flow and extensive use is made of complex variable methods. It is shown that the lift of the combination of wing and nacelles is usually larger than that of the same isolated wing. Some consideration is also given to nacelles having separate internal flow.

In the supersonic regime, interaction effects are shown to be important if the various elements of the combination are located within the Mach cone emanating from the apex of the wing. To estimate the aerodynamic characteristics of the combination, the author seems to make use of Ward's theory of supersonic flow past slender, pointed bodies.

A discussion of the transonic flow past a thin, wedge-shaped profile at small incidence is also of interest. The continuation of the subsonic solution past the sonic line is carried out in the hodograph plane using analytical methods. As part of the result of this investigation the pressure distribution over the profile is calculated as a function of incidence.

Readers interested in fields outside of aerodynamics may find in this issue several valuable contributions to the theory of elasticity and plasticity as well as miscellaneous topics in connection with systems of ordinary differential equations (linear and non-linear).

DR. P. MANDL

Physical Laws and Effects. By C. F. HIX, JR., and R. P. ALLEY. John Wiley & Sons, Inc., New York, 1959. 291 pages. Illus. $7.95.

Hix and Alley have produced here a unique compilation of physical phenomena, laws and effects. The value of the book lies chiefly in the inclusion of all known (to the authors) laws and effects, no matter how insignificant and unapplied they may be. Each item is described under the headings: Description, Illustration, Magnitude including formulae, References and Quantities. There is an alphabetical index, a cross reference by physical quantities and a cross reference by fields of science.

A designer or inventor can enter this book using clues such as the desired output or the available input and quickly find effects operating on these quantities. General reading of the book may stimulate ideas for new processes or products or better ways of doing things. Limits, reversals and turning points are clearly described.

Subjects presented are varied and numerous, including for instance Archimedes Principle, Bremstrahlung Radiation, Friction Effects, Le Chatelier's Law, Newton's Laws, Quantum Theory and Triboelectricity. Some omissions have been noticed, however, such as Parity Laws, Electron Spin Relationships and Thermoluminescence.

A large number of entries are included in an Addendum because there was not time for research and/or checking the accuracy of these items. Fair enough, but some of the items are surprising and surely should be included in the main body of the text. Examples are: Bernoulli's Equation for a jet, Bohr's Theory, Fraunhofer Lines, Heisenberg Uncertainty Principle, Maxwell's Equations and Einstein's Principle of Relativity. Items in this Addendum are not included in the cross references.

Here is a reference book that would be useful to electrical, electronics, instrument and telecommunications design engineers, physicists and inventors. It is of general interest and reference use to a much wider group of scientists, engineers and technically-minded people.

DR. D. A. MACLULICH

Aviation Directory of Canada 1959. Farm Equipment Publishing Co. Ltd., Toronto. 196 pages. Canada $4; British Empire and U.S.A. $5.

This directory, published by Aircraft magazine and looking very like an overgrown edition of one of their monthly issues, is useful, because it does not try to do too much. It is quite well arranged and easy to find one's way about in. Moreover, perhaps because of its relative simplicity, it is tolerably up to date.

By far the worst thing about it is its very dirty printing. Its cover too could be improved; the rather flimsily taped back not only carries no identity — which is a nuisance in a bookshelf — but comes off altogether with a little use; at least it did last year.

H. C. LUTTMAN

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MEMBERSHIP OF THE C.A.I.

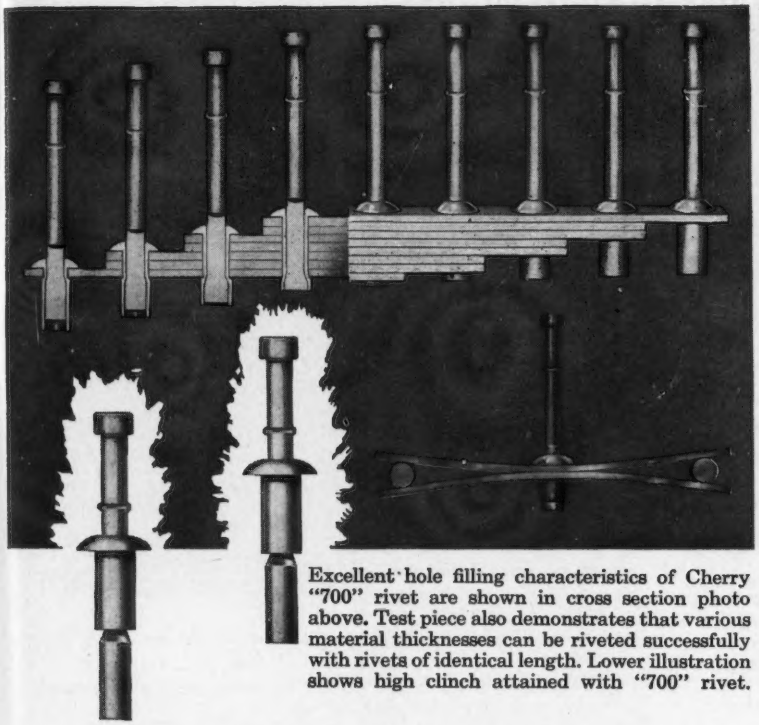
THE qualifications and annual dues set out in the table below are those presently laid down by the By-laws. The rates of dues shown in brackets are those applicable to members resident outside Canada or the U.S.A.

The annual dues include a non-deductible subscription to the *Canadian Aeronautical Journal.*

Application forms may be procured from the Secretaries of the Branches or from C.A.I. Headquarters. An applicant does not apply for membership in any particular grade, but each application is considered by the Admissions Committee, who decide the grade suitable to the applicant's qualifications. On admission, the applicant is informed of his grading and the appropriate entrance fees and annual dues.

The entrance fee is $5.00, except in certain special circumstances.

Grade	Summary of Qualifications	Annual Dues
Student	Undergoing a course of study at an approved school of engineering or technology	$3.00 ($2.00)
Junior Member	Engaged in technical work in aviation	$5.00 ($2.00)
Technical Member	Engaged in science, engineering, research, manufacture or operation, in aeronautics or related fields for 4 years or graduated from an approved school of engineering or science	$8.00 ($5.00)
Member	Engaged in technical work in aeronautics or related fields for 8 years and acquired a recognized standing	$10.00 ($6.00)
Associate	Engaged in aviation, though not qualified for technical grades	$15.00 ($10.00)
Associate Fellow	Engaged in aeronautical science or engineering for 10 years and been in responsible charge or made outstanding contribution	$15.00 ($10.00)
Fellow	Been an Associate Fellow for 1 year and attained distinction in aeronautics	$15.00 ($10.00)



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INSTRUCTIONS TO CONTRIBUTORS

The Canadian Aeronautical Institute invites the submission of papers, articles and technical notes for publication in the Canadian Aeronautical Journal. Following the practice of other societies, the Institute does not pay for contributions.

Authors should prepare their material in accordance with the following directions:

Manuscripts. Manuscripts should be
(a) Typewritten, double-spaced,
(b) On one side of 8½ x 11 white paper,
(c) With wide margins, approximately 1½", and
(d) With pages numbered consecutively.

Manuscripts must be in final form; the addition of material after acceptance by the Institute cannot be permitted.

Titles. The following form should invariably be adopted:–
(a) Titles should be brief;
(b) The name and initials of the author should be written as he prefers; (Rank or title preceding the name e.g. Wing Commander or Dr., should be included but abbreviations of degrees etc., after the name, should be omitted.);
(c) The name of the organization with which the author is associated should be shown under his name; and
(d) The author's position in the organization, referred to in (c) above, should be shown as a footnote to the first page.

Summaries. Each paper should be preceded by a summary
(a) Of 100 to 300 words, (10 to 35 lines, double-spaced),
(b) In non-specialist language, so far as possible,
(c) Stating the main conclusions of the paper.

Sub-Headings and Paragraph Numbering. Sub-headings should be inserted by the author at frequent intervals. Paragraphs should not be numbered.

References. References referred to by the author should be treated thus:–
(a) References should be numbered consecutively throughout the paper;
(b) An allusion to a reference should be indicated by a bracketed numeral e.g. "It has been shown by Dr. T. T. James (7) . . . ";
(c) Direct citation of a reference in the text should be written in full, e.g. "As shown in Reference (7) . . . "; and
(d) References should be grouped together in numerical order at the end of the paper, each showing
first, the numerical designation, e.g. "(7)".
second, the author's name, e.g. "James, T. T."
third, the title of his work, e.g. "Aerodynamics and Ballistics"
fourth, the title, volume, issue no, and date identifying the publication in which it appeared, e.g. "R.B.S. Journal, Vol. 7, No. 77, July 1907".

Thus "(7) James, T. T.,–Aerodynamics and Ballistics, R.B.S. Journal, Vol. 7, No. 77, July 1907."

Footnotes. Comments on or amplification of the text should be given in footnotes, appearing at the bottom of the appropriate pages.
(a) Footnotes should be designated alphabetically and consecutively throughout the paper; and
(b) A reference to a footnote in the text should be indicated by a bracketed letter, e.g. "omitting consideration of the third power (c) . . . "

Figures, Tables and Equations. Reference in the text to
(a) Figures and Tables should be given in full, e.g. "Figure 7", but
(b) Equations should be abbreviated to Eq., e.g., "Eq.(7)" or "Eqs.(5) and (6)".

Drawings. Drawings should be
(a) Individually identified by Figure or Table number,
(b) Not larger than 12" x 16",
(c) In black ink on white paper or tracing cloth, and
(d) Capable of being reduced to 3¼" wide without loss of legibility of lettering or other detail.

Photographs. Photographs should be
(a) Black and white, glossy prints, and
(b) Individually identified by Figure number, written on a separate piece of paper affixed to the back: writing on the back of the photographs should be avoided.

Captions. Each Figure and Table should be identified by a caption, in addition to its number, e.g., "Figure 12 Theoretical lift distribution".
(a) The caption of a Table should be shown at the top of the Table;
(b) The caption of a Figure should be shown preferably outside the boundary of the Figure; and
(c) A complete list of Figure and Table captions should be given on a separate sheet of the manuscript.

Mathematical work. Only the simplest mathematical expressions should be typewritten; others should be carefully written in ink. Mathematical work should be
(a) Uncrowded–plenty of space should be provided to accommodate directions to the printer–,
(b) Repeated on a separate sheet of the manuscript, again uncrowded and with plenty of space around each expression,
(c) Clearly written to distinguish between like symbols. e.g. between zero and the letter 'o', and between Greek and English letters of similar form, and
(d) Accompanied by a manuscript "index" of the Greek letters used in the paper, identifying each letter by a name, e.g. "α–alpha".

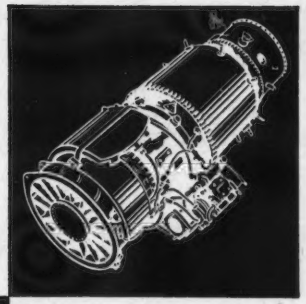
In addition the following practices should be adopted:
(a) Simple fractions appearing in the text should be shown with a solidus, e.g. A/(B+C) rather than as

$$\frac{A}{B+C}$$

(b) Complicated expressions should be identified by some convenient symbol, if necessary to avoid repetition of the whole expression; and
(c) Complicated subscripts and exponents, and dots and bars over letters or symbols should be avoided.

Symbols and Abbreviations. Consistency is important;
(a) The symbols recommended in the American Standards Association "Letter Symbols for Aeronautical Sciences" ASA Y10-7–1954 should be used wherever practicable; and
(b) Abbreviations of units should be shown in lower case without periods, e.g. lb, mph, bhp, etc.

Mailing. Papers should be mailed to The Secretary, Canadian Aeronautical Institute, Commonwealth Building, 77 Metcalfe St., Ottawa 4, Canada.
(a) Drawings and photographs may be mailed rolled or flat, not folded;
(b) Manuscripts should be mailed flat.



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